Experimental and Research Station,

Nursery & Market Garden Industries' - - Development Society, Limited. - -

Turner's Hill, Cheshunt, Herts.

TELEPHONE: WALTHAM CROSS 2150.

Thirtieth Annual Report, 1944.

THE CHESHUNT PRESS, LIMITED.

1945.

The abbreviated title of this Report as given in the World List of Scientific Periodicals is :—

Rep. Exp. Res. Sta., Cheshunt, 1944.

Nursery and Market Garden Industries' Development Society, Limited.

OFFICERS, 1944-45.

President :

* J. NEILSEN, Esq.

Hon. Treasurer :

* A. A. POLLARD, Esq., J.P.

Committee of Management :

† PROFESSOR V. H. BLACKMAN, M.A., D.Sc., F.R.S.
E. A. BOWLES, Esq., M.A., V.M.H., (Middx. County Council).
* L. MADSEN, Esq.
* E. GALLOWAY, Esq.
* G. C. GOODCHILD.
* C. J. HORWOOD, Esq.
E. STEVENS, Esq.
† SIR E. JOHN RUSSELL, O.B.E., D.Sc., F.R.S.
* A. RHODES, Esq.
R. N. SALAMAN, Esq., M.D., F.R.S. (Herts County Council)
H. V. TAYLOR, Esq., O.B.E., D.Sc., V.M.H.
§ W. H. YOUNG, Esq.

Auditors :

Messrs. George Cobley & Co., 33, Henrietta Street, Covent Garden, W.C.2.

Bankers :

Midland Bank, Limited.

Solicitors :

Messrs. Hutchison & Cuff, 6, Stone Buildings, Lincoln's Inn, W.C.

† Nominated by the Committee of the Lawes' Agricultural Trust, Rothamsted Harpenden, Herts.

* Nominated by the Lea Valley Growers' Association, Limited.

§ Nominated by the Worthing Growers.

Experimental and Research Station.

SCIENTIFIC STAFF.

Director :
W. F. Bewley, C.B.E., D.Sc. (Dunelm), V.M.H.

Entomology :

E. R. Speyer, M.A. (Oxon), F.R.E.S.	Entomologist.
W. J. Parr	Technical Assistant

Mycology :

P. W. Williams, B.Sc. (London)	General Mycology.
Enid Sheard, B.Sc. (London)	Diseases of Flowers.
I. W. Selman, B.Sc. (London), Ph. D.	Virus Diseases.
R. Layzell	Laboratory Attendant.
P. Harris	,, ,,

Chemistry :

O. Owen, M.Sc. (Wales), Ph.D., F.R.I.C. ...	General Chemistry.
P. O. Rees, B. Pharm. (Wales)	,, ,,
W. H. Read, M.Sc. (B'ham.), A.R.I.C.	Insecticides and Fungicides.
† J. A. Palgrave	Technical Assistant in General Chemistry.
G. Percival	Laboratory Attendant.
R. Pawley	,, ,,

Extension Officer :
O. B. Orchard.

Director's Technical Assistant :
J. E. Morton, A.R.P.S.

Secretary :
Gwendolen Dunster, B.A. (Lond.)
Assistants : Joyce M. Masson and Dorothy M. Shaw.

Nursery Manager and Demonstrator :
A. A. Richards.

Nursery Staff—Foreman : T. W. Syer. Assistants : A. Banham, F. Blake, H. J. Newman, F. W. Butler†, K. Eden, A. E. Judd, J. H. Smith, G. Tyrrell, L. Wilkinson†, I. Wilkinson

† Absent on Military Service.

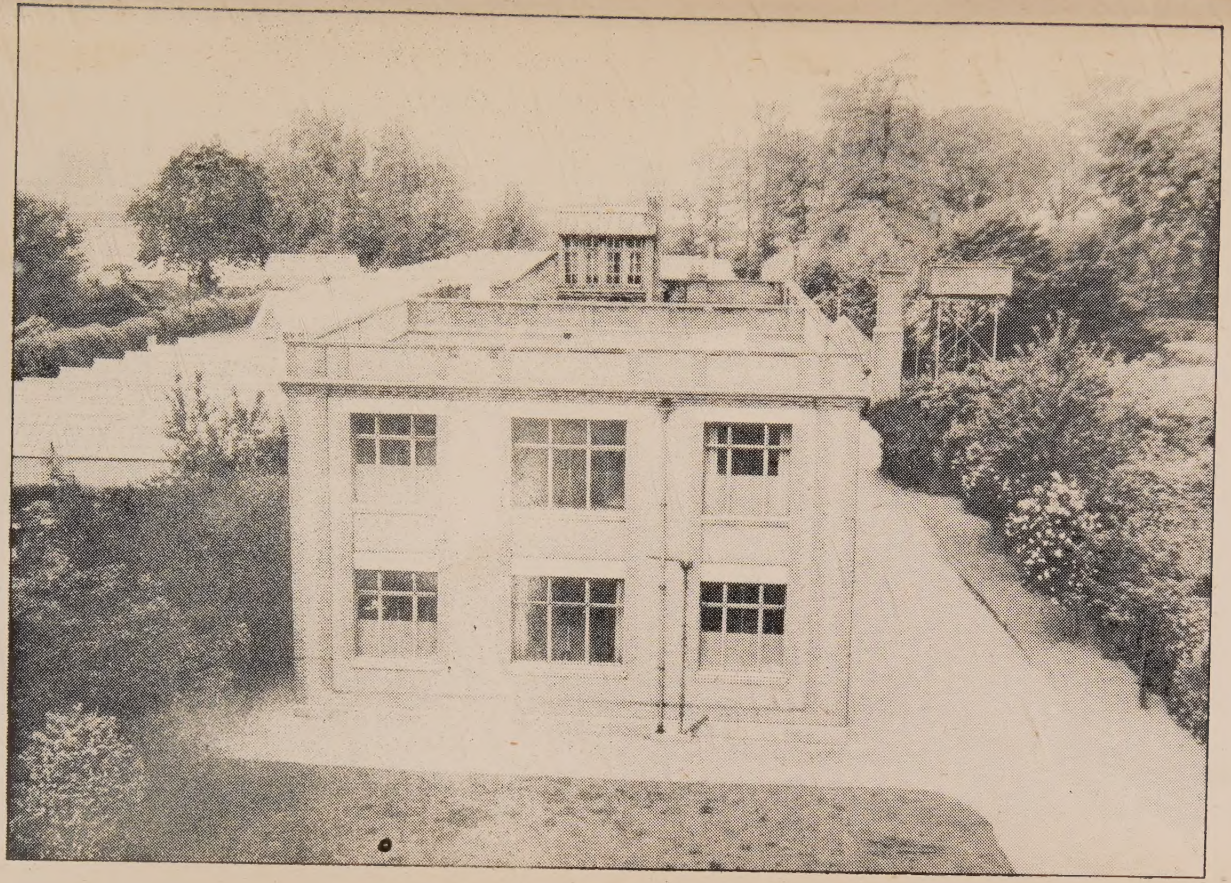

TABLE OF CONTENTS

Page

INTRODUCTION 9

1. DIRECTOR'S REPORT of the Experimental Results of 1944

1. Sulphate of potash versus muriate of potash 15
2. Organic manure for the base 16
3. Variety trials 17
4. Gravel cultures 18
5. National trials of outdoor tomatoes 18

2. REPORT OF THE EXTENSION OFFICER 20

3. PLANT DISEASES

1. General 21
2. Verticillium wilt 21
3. Didymella Stem Rot of Tomatoes 24
4. Note on the rotting of heliotrope cuttings by *Corticum solani* 26
5. Susceptibility of lettuce to Mosaic infection in relation to soil conditions 26
6. Watering frequency and the effect of Mosaic on tomato plants 28
7. Observations on the Tomato Spotted Wilt virus disease of the Arum lily 30

4. ANIMAL PESTS

1. Red Spider-mite (*Tetranychus telarius L.*) 32
2. Fumigation of lettuce with hydrogen cyanide 33
3. Nomenclature of Aphides 36
4. Tomato Moth 38
5. White-fly (*Trialeurodes vaporariorum* Westwd.) 39
6. Leaf-miners of tomato (*Liriomyza spp.*) 41
7. A fruit-fly in relation to grape vine 53
8. Scarabaeid Beetles as pests of mushrooms 53
9. Root-knot Eelworm (*Heterodera marioni* Cornu) 53
10. Control of Tomato-moth Caterpillars with preparation containing D.D.T. 54

TABLE OF CONTENTS (*continued*).

Page

5. CHEMICAL PROBLEMS

1. General 58
2. The use of muriate in place of sulphate of potash 58
3. The effect of sulphur and sulphuric acid on the reaction of a tomato soil 61
4. Trace elements in tomato nutrition 61
5. Magnesium deficiency in tomatoes 65
6. Trace elements in lettuce nutrition 65
7. The effect of 2.4-dichlorphenacetic acid and beta-napthoxyacetic acid on fruit setting in tomatoes 66
8. The determination of " available " potash and phosphoric acid in tomato soils 66

APPENDIX:

A. Publications 76
B. Manurial Treatments 82
C. Manurial Treatments 83
D. Cultural Operations 83

Diagram showing arrangement of Experimental plots in 1944.

Introduction.

THE work of the Research Station which despite several previous disturbances has proceeded actively during the war period, suffered a serious set-back last July, owing to enemy action. Scientific research in the laboratories was suspended for a few days only, but the experiments in the glasshouses were ruined and the crop records covering two months only are of little value. The damage was repaired, however, in time for the winter lettuce crop.

The fourth National Trial of Outdoor Tomatoes was organised with the help of county officers. Twenty-seven English counties and six Welsh counties took part. Dwarf and bush types of tomatoes were compared with Ailsa Craig.

A third short Course on commercial glasshouse work was arranged for the three days commencing Monday, May 22nd. Sixty-seven horticultural officers attended : an increase of five over last year.

At the request of the Agricultural Research Council the Station continued to co-operate with Professor Todd of Manchester University in the preparation of a root exudate of the tomato.

Current Investigations.

The experiments which were commenced in 1940 to study the relative effects of muriate and sulphate of potash upon the tomato crop have been continued. Although the crop was damaged seriously in July, the crop yield for the first two months and the general appearance of the crop, confirmed previous results which indicated that sulphate of potash may be replaced by the muriate for at least five years, so far as the soil at the Station is concerned. Harmful results, however, may arise if the soil is naturally rich in chloride.

In co-operation with Rothamsted Experimental Station, an experiment was arranged to test the relative effects of horse manure, ADCO composted straw and sewage-straw compost applied to the soil before planting.

Variety Trials were continued as in the past, but the records for two months only are of little value.

The cultivation of tomatoes and carnations in gravel moistened with a water culture solution was commenced. The early stages of the crops appeared promising, but unfortunately the experiments could not be continued to the end of the season.

Tomatoes were grown for the fifth year in cucumber houses using the roof-crop method. The plants gave every promise of an exceptionally heavy crop prior to the incident. In two houses, the four middle rows were replaced by twice the number of tomatoes in size "32" pots. Each plant was stopped at the second truss. The high average yield of 3.1 lbs. per pot was obtained by this means.

Cheshunt Early Giant lettuce in heated glasshouses and Cheshunt Early Ball in cold houses and frames have both maintained their previous standard of excellence. Present day stocks show an excessive proportion of rogue plants, but precautions are being taken to correct this when peacetime conditions return.

Pure culture experiments have shown that the growth of both *V. albo-atrum* and *V. dahliae* remain unaffected over a wide range of acidity in the medium, and the control of wilt disease by alteration of the soil reaction seems to be out of the question. Inoculation experiments suggest that *V. dahliae* produces a milder type of disease than *V. albo-atrum* but damage to the glasshouse prevented a full series of experiments from being carried out.

Further records of the two fungi have strengthened the hypothesis that *V. dahliae* is confined to the south of England.

Didymella lycopersici proved capable of surviving for short periods at temperatures regarded previously as being lethal. Naked pycnospores withstood desiccation for a considerable period. Tomato plants growing freely under ideal conditions and those under more restricted conditions in a poorer soil were alike attacked by this fungus. Records collected with the assistance of county horticultural advisers showed that the greatest amount of infection occurred in May and June.

Further attempts have been made to find a control for this disease but no effective fungicidal treatment has been found. The results of a number of trials with salicylanilide sprays on commercial nurseries were disappointing. Trials in houses at the Research Station were inconclusive owing to the destruction of many of the plants by enemy action.

The susceptibility of Cheshunt Early Giant lettuce to infection by the mosaic virus has been studied in relation to nitrogen, phosphate and water supply. Plants receiving high nitrogen and medium phosphate applications were most susceptible while those receiving low nitrogen, low phosphate and medium water treatments were most resistant. Evidence was obtained to indicate that the available nitrogen content of the soil may be a factor of importance in determining susceptibility to mosaic infection.

A study of the water relations of virus infected tomato plants has been commenced. It has been found that inoculation of tomato foliage with sap containing a tomato virus may result in an increased rate of water loss which is detectable three days after inoculation and before symptoms of disease are visible as a growth response. There is evidence that this effect is upon

cuticular transpiration. An experiment to investigate the influence of watering frequency on the fruit yield of healthy and mosaic infected tomato plants showed no significant interaction between water application and yield reduction due to mosaic infection.

Owing to enemy action, the results of experiments in methods of applying petroleum oil emulsion for the control of Red Spider-mite could not be obtained but a further study of the distribution of infested plants in tomato houses showed that, early in the growing season, the mites gain access first to plants adjacent to the centre path, unless artificially distributed upon plants already infested in the propagating house.

The application of a solution of sodium thymolate to infected soil, before planting up, was ineffective in affording to the plants protection from attack by Root-knot Eelworm.

An extensive series of experiments showed that lettuce can be fumigated with hydrocyanic acid gas in concentrations above those necessary to obtain complete control of Aphids, without injury to seedlings or to older plants growing in the ground.

The value of D.D.T. for the control of insect pests of glasshouse crops has been examined. Excellent control of caterpillars of the tomato moth (*Polia oleracea*) has been obtained in laboratory and small scale commercial trials with dusts and sprays containing this insecticide. D.D.T. is compatible with petroleum oil emulsions.

The development of the larvae within the egg was not materially affected by application of sprays containing emulsions of D.D.T., but in the case of eggs in the upper portions of the egg-masses, the larvae though fully developed, were too weak to perforate the shell. In the case of some eggs situated upon or near the floor of the egg masses, and when the masses were sprayed shortly before the time of hatching, the

larvae perforated the shells but died before making their escape from them. When a 5% D.D.T. dust was applied, in some cases up to 50% of the larvae hatched successfully.

Dusts containing D.D.T. have also shown very promising results in trials against sciarid flies which cause considerable loss in commercial mushroom growing. Red Spider-mites (*Tetranychus telarius*) do not appear susceptible to D.D.T. but preliminary trials with white-flies (*Trialeurodes vaporariorum*) suggest that the addition of D.D.T. to petroleum oil emulsions may be of value in controlling this pest.

Work is proceeding on the investigation of problems connected with chemical soil sterilization.

Periodic determinations of chloride concentration in the soil of plots used for comparing the effects of muriate and sulphate of potash have been continued, and analyses of foliage have been made. As reported last year there are inexplicable variations in the chloride contents of the plots. The highest sodium chloride value recorded during the year was 0.27 per cent. This value was not maintained and had fallen to less than half in just over three weeks. Values in all plots had fallen considerably by the beginning of June, and did not rise appreciably after that. Indeed, later values generally were low and reductions shown after the heavy flooding with water following steaming in October, were not so great as those shown during the corresponding period of 1943.

During the year applications of sulphur at the rate of 2 ozs. and 4 ozs. per yard respectively had little effect on the general level of pH in our soil. It is concluded that these dressings are insufficient to bring about a reduction in pH and it is proposed to try heavier dressings next year.

Experiments on the rôle of trace elements in tomato nutrition have been continued. With a view to correct-

ing deficiencies under commercial conditions the use of magnesium and manganese sulphates as sprays has been examined further. Epsom Salts at a concentration of 2 per cent. in water can be used under most conditions to correct magnesium deficiency and the addition of a wetting agent eliminates any risk of damage by scorching. Manganese sulphate at a concentration of 0.75% in water can be used for manganese deficiencies under certain conditions.

Work on the effects of some of the acute deficiencies on the lettuce Cheshunt Early Giant is in progress.

A comparison is being made of the amounts of potash and phosphoric acid extracted from a tomato soil by different solutions, in an attempt to determine one which gives results most nearly related to the actual needs of the crop. The indications are that under our conditions 0.5 N. acetic acid solution is most promising.

Additions of superphosphate were without apparent effect on the plants but, as was to be expected, produced an immediate increase in the amount of phosphoric acid extracted from the soil by distilled water. Over the whole season there was an increase in phosphoric acid extracted by acetic acid solution buffered at pH 4.8, but there was little effect on that extracted by the other solutions used.

Over the whole season there was an increase in the potash extracted by 1 per cent. citric acid and 0.5 N. acetic acid but a reduction in the amount extracted by distilled water. It is interesting to note that there were indications in the crop of an inadequate level of potash, despite additions of sulphate of potash to the soil. Winter flooding at the end of the 1943 season caused an appreciable reduction in the extractable potash. By March, 1944, however, potash extracted by citric and acetic acids respectively had increased, despite the fact that no addition of fertiliser had been made. At the same time potash extracted by distilled water showed no such increase.

1. DIRECTOR'S REPORT
OF THE
Experimental Results of 1944.

Owing to the glasshouses being seriously damaged by enemy action in July 1944, the crop was ruined. The Committee of Management, however, decided that the experiments for the year should be described, and the crop weights for the first two months of picking published in this report.

(A) Tomatoes.

The practice of grading the tomato fruits from the experimental plots, adopted in 1921, was continued ;-

A.—" Pinks " number 5 to 7 and " Pink and White " 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour ; " Pinks " being slightly larger than " Pink and Whites"

B.—" Whites." These fruits are of good colour but smaller than " Pink and White."

C.—" Blues." This grade consists of fruits of good colour but larger and more irregular in shape than Grade A.

D.—" Roughs." Small mis-shapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits showing Blossom End Rot.

G.—Fruits showing the lesions of Streak Disease.

H.—Fruits showing " Green Back."

1. Houses 7-9. Sulphate of potash versus muriate of potash

At the commencement of the War a possible future shortage of sulphate of potash was visualised, and therefore in 1940 arrangements were made to compare the relative effects of sulphate and muriate of potash year by year in the same plots. Houses 7-9 were allocated for this purpose, 7 and 8 being planted with the variety Potentate and 9 with E.S.1. Each house was divided into four equal plots. Two of these received the normal manurial treatment, and in the others the sulphate of potash was replaced by the equivalent amount of muriate of potash. The normal treatment is as follows :—

1.—Applied before planting

Hoof and horn	10 cwts.	} per acre.
Bone meal	10 cwts.	
Sulphate of potash	10 cwts.	

2.—Top dressing

(*a*) Sulphate of potash 5 cwts. per acre.
(*b*) A top-dressing mixture containing 10% potash as sulphate of potash totalling 20 to 30 cwts. per acre as required.

Table 1

House	Plot	Treatment	Crop yield in lbs. per plant			Total tons per acre	
			June	July	Total		
7	1	Sulphate of potash	2.52	2.87	5.39	40.96	
	3	,, ,,	2.45	2.96	5.41	41.12	
8	2	,, ,,	2.37	3.06	5.43	41.27	35.41
	4	,, ,,	1.95	2.66	4.61	35.03	
9	1	,, ,,	1.20	2.87	4.07	30.92	
	3	,, ,,	0.52	2.79	3.31	25.16	
7	2	Muriate of potash	2.46	2.86	5.32	40.44	
	4	,, ,,	2.33	2.79	5.12	38.93	
8	1	,, ,,	2.36	3.01	5.37	40.82	35.38
	3	,, ,,	1.78	3.18	4.96	37.71	
9	2	,, ,,	0.90	2.83	3.73	28.35	
	4	,, ,,	0.70	2.72	3.42	26.00	

Varieties: Houses 7 and 8 Potentate
House 9 E.S.1.

The results given in Table 1 help to confirm those obtained during the past four years. Information relating to the chloride content of the soil will be found in the Chemical section of this report.

2. Organic manure for the base

In conjunction with Rothamsted Experimental Station, an experiment was arranged in house 3, to test the relative effects of horse manure, straw composted with sewage sludge, and straw composted by the A.D.C.O. process. A fourth plot to which no bulky organic matter of any kind had been applied was left as a control.

The house was divided into four blocks in each of which the four treatments were randomised.

The sewage sludge compost was imported from Rothamsted: the A.D.C.O. compost was prepared at the Research Station. Applications were made at the rate of 30 tons per acre, followed by the usual base fertilisers and top dressing treatments as required. All plots, however, were treated similarly in respect of fertilizers and crop management. The results of two months pickings are given in Table 2.

Table 2

Plot	Treatment	June	July	Total	Total ton per acre
8	R. Sewage Compost	0.86	2.03	2.89	22.04
7	Stable	1.23	1.94	3.17	24.32
9	Control	1.14	1.61	2.75	21.28
10	ADCO	1.46	1.76	3.22	24.32
6	Sewage	0.76	1.79	2.55	19.76
5	Control	0.97	1.90	2.87	22.04
11	ADCO	1.25	1.77	3.02	22.80
12	Stable	1.35	1.98	3.33	25.08
4	ADCO	0.93	1.87	2.80	21.31
3	Stable	0.86	1.65	2.51	19.00
13	Control	1.15	1.95	3.10	23.56
14	Sewage	0.91	1.67	2.58	19.76
1	ADCO	1.00	1.56	2.56	19.71
2	Control	0.62	1.41	2.03	15.96
15	Sewage	0.91	1.50	2.40	18.24
16	Stable	1.13	1.49	2.62	19.82

3. Variety Trials

Variety trials were carried out in the Rose House, turned over to tomatoes in 1941. The yields for the first two months are given in Table 3.

Table 3

Variety	Crop weight in tons per acre (June and July)
E.S.1.	47.16
Pomfret Castle ...	44.84
Robinson's Graday ...	44.72
Comet	40.28
Bountiful	38.76
Rodbaston	35.57
V.C.	34.42
Carrick	31.39

In House 10 a comparison was made between Potentate, J.H.2. and Harnett's Ideal. The results were as follows in Table 4.

Table 4

Variety	Crop weight in tons per acre (June and July)
Potentate	32.76
J.H.2.	31.77
Harnett's Ideal ...	29.71

4. Gravel Cultures

The south half of house 2 was devoted to the cultivation of tomatoes and carnations in gravel cultures, using the Mullard System of troughs, tanks, etc.

Eight troughs each 20 feet long and 2 feet wide were installed, the average depth of the gravel aggregate being eight inches. At the end of each of four of the troughs a tank was constructed to hod sufficient nutrient solution to fill its trough. The solution was pumped into the bottom of each of these four troughs until it appeared at the surface of the gravel, then the pump was stopped and the liquid allowed to flow back into the tank. This wetting of the gravel aggregate was performed morning and late afternoon. In the remaining four tanks, water was applied from a hose in the usual way, and the food materials were applied as top dressings to the surface of the gravel. Six troughs were planted with tomatoes : two with carnations. Three of the six tomato troughs and one carnation trough were irrigated with nutrient solution, the remainder being watered and fed from the top. One soil bed of carnations was planted to serve as a control.

All cultures were making good progress when the house was damaged and the experiments ruined.

5. National trials of out-door tomatoes

The fourth of the series of National Trials of outdoor tomatoes was organised with the kind co-operation of County staffs at 43 centres in England and 8 centres in Wales.

The trials this year were simple in character for they were limited to a variety trial of four dwarf varieties. Stonors Dwarf Gem, Stambovoi, Bizon and First in the Field ; two bush varieties Fargo and Victor ; with Ailsa Craig as the control.

The County Officers and growers who were responsible for the cultivation at the different centres were not impressed by any of the varieties tested. Many stated that they do not compare favourably with the best standard outdoor varieties, others that they are not suitable for commercial work. Many agreed, however, that Dwarf Gem, Stambovoi, and First in the Field are worth further trial. This is probably a fair opinion of the varieties tested. Victor, which proved an interesting variety when grown at Cheshunt during 1942 and 1943, was ruined in 1944 by the excessive rainfall. Previously it had produced two trusses of reasonably good fruit and then stopped itself. In 1945 it produced a mass of side shoots and failed to set any fruit until late in the year.

Such fruit as set were small and worthless. Bizon produced ugly fruit, and is not resistant to frost. Its only virtue is its earliness. Fargo was not regarded as a success when grown in the open in 1943 but has proved useful under continuous cloches. Stambovoi and First in the Field are very similar dwarf varieties but not identical. (Q77 another dwarf variety is also similar to First in the Field).

These varieties seem to be fairly resistant to unfavourable weather conditions but cannot be regarded as frost resistant.

Dwarf varieties constitute an interesting type. At present they can hardly be regarded as commercial varieties, but hybridists may give us ultimately a variety of outstanding merit.

2. REPORT OF THE EXTENSION OFFICER.

O. B. ORCHARD

Experiments conducted on the nursery at the Research Station during 1943 (Ann. Rept. 1943, p. 18-22) showed that when stable manure was dug into the soil which had been sterilised by steam, no appreciable increase of the tomato crop was obtained during the following season when compared with plots from which the manure was omitted.

During the year 1944, it has been possible through the kind co-operation of the owners to carry out similar experiments on five commercial nurseries situated in the Lea Valley. On each nursery the soil was sterilised by steam during the winter 1943-44, and complete houses side by side were used for comparison. In the manured houses, stable manure was applied at the rate of approximately thirty tons per acre, and the variety Potentate was grown on each nursery. It was not possible to obtain records of pickings of fruit other than the total crops owing to labour problems. These records are given in the accompanying Table.

Table 1

Nursery No.	Area	Treatment and Crop in Tons per acre	
		Stable Manure omitted	Stable Manure Added
1	908 sq. yards	47.6	——
	908 ,, ,,	——	50.8
2	1,244 ,, ,,	52.0	——
	1,244 ,, ,,	——	55.0
3	1,154 ,, ,,	51.3	——
	1,154 ,, ,,	——	54.5
4	498 ,, ,,	73.2	——
	498 ,, ,,	——	76.5
5	1,154 ,, ,,	59.0	——
	1,154 ,, ,,	——	61.3

Examination of the above table shows that on each nursery a slight increase of crop was obtained where stable manure was applied, the average increase on each of the five nurseries being three tons per acre.

Analysis of soil samples taken from the nurseries after steaming showed that in each case the manurial value was comparatively high, and this possibly influenced the results, which suggest that under such conditions the addition of stable manure after sterilisation by steaming does not greatly increase the crop yield for the following crop.

3. PLANT DISEASES.

1. General

P. H. WILLIAMS

The number of specimens received during 1944 showed an increase of 29% on those for 1943. Of the total of 635, 549 or 86% were tomatoes and 71% were received during the summer months, May to August.

As in previous years, diseases caused by species of *Phytophthora* were the most abundant and were found in 23% of the specimens examined. A number of specimens from county advisers were examined for *Didymella* so that the large number of cases recorded (20% of the whole) does not give a true picture of the relative importance of this fungus. Other diseases remained at about the same frequency as in previous years.

2. Verticillium Wilt

P. H. WILLIAMS

The effect of acidity on growth in pure culture

Several workers have reported that the severity of attacks of *Verticillium* wilt of Egg plants was reduced by increasing the acidity of the soil by adding sulphur. Liming on the other hand by reducing the acidity made the disease more severe. The exact species of *Verticillium* concerned is not always clear from the published accounts and therefore experiments were set up to determine the effect of the acidity of the medium on both *Verticillium albo-atrum* and *V. dahliae* in pure culture.

The cultures used were strain 57, a culture of *V. albo-atrum* isolated in 1943 and strain 49, a single spore culture of *V. dahliae* used in previous experiments. The acidity of the medium was adjusted by adding an equal volume of a buffer mixture to 10 cc of double strength potato or Czapek agar. The buffer solutions used were :—

A. Sorensen's phosphate mixtures, pH 4.0-8.0

B. Sorensen's citrate-hydrochloric acid mixtures, pH 3.0-5.0

C. McIlvaine's Standards, citric acid and sodium phosphate, pH 3.0–8.0

The solutions were prepared at double strength so that when mixed with the agar both were at normal strength. The buffer mixtures and agar were sterilised separately and mixed just before use. Four plates were poured at each acidity, two for each fungus.

In one experiment potato agar was used and in a second Czapeks agar. The mean increase in diameter in centimetres of cultures after 7 days at 25° C is shown in Table 1.

Table 1
Effect of pH of medium on growth

	pH.	*V. albo-atrum*		*V. dahliae*	
		Potato	Czapek	Potato	Czapek
A1	4.0	2.6	2.1	C	3.3
A2	5.0	2.4	2.1	3.6	3.3
A3	6.0	2.4	2.0	C	3.1
A4	7.0	2.3	2.0	3.2	3.0
A5	8.0	2.9	2.3	3.2	2.7
B1	3.0	2.1	0.4	0.7	C
B2	4.0	2.3	1.9	2.6	2.1
B3	5.0	2.3	2.2	2.9	2.0
C1	3.0	0.9	NG	NG	NG
C2	4.0	2.6	2.2	3.0	2.4
C3	5.0	2.7	2.2	2.9	2.4
C4	6.0	2.8	2.0	2.9	2.5
C5	7.0	2.4	C	2.8	C
C6	8.0	2.3	1.9	2.4	2.0

N.G.—No Growth. C.—Contaminated.

From these results it would appear that both fungi grow well between pH 4.0 and 8.0, but that below pH 4.0 growth is inhibited or retarded. The effect is more pronounced when they are grown on Czapek's agar which is itself slightly acid so that the actual acidities will be slightly below the theoretical level. Acidities obtained by this method are only approximate and the effect of the acidity is also modified by the direct effect of the substances contained in the buffer solutions on the fungi. Nevertheless the results are sufficiently accurate to suggest that it would not be possible to acidify the soil to such an extent as to make it unfavourable for the growth of *Verticillium*.

The effect of *V. albo-atrum* and *V. dahliae* on tomato plants

In an experiment carried out in 1942 for the purpose of testing possible seed transmission of *Verticillium* wilt Ailsa Craig plants were inoculated with *V. albo-atrum* and *V. dahliae*. The plants were grown in 10 inch pots and were inoculated by placing a piece of culture of the appropriate fungus under the ball of roots when planting. They were planted on April 23rd, and by May 22nd those inoculated with *V. albo-atrum* showed severe wilt symptoms. Subsequently they recovered and later growth was normal, the only signs of infection being the short internodes and aborted trusses formed during the acute phase of the disease. The plants

inoculated with *V. dahliae* showed no signs of disease on May 22nd but typical yellowing of the lower leaves by June 1st. They continued to grow regularly and showed no shortening of the internodes or abortion of trusses.

The experiment was repeated in 1944 using the varieties Ailsa Craig, Vetomold and Riverside. Similar results were observed, Ailsa Craig being the most severly affected. Further experiments on these lines designed to test the effect of temperature on the diseases caused by the two fungi were prevented by enemy action.

Seed transmission

It has been claimed that *Verticillium* Wilt of tomato and other plants may be transmitted by the seed. The fungus may be carried both on the outside of the seed or in the embryo. Accordingly seed was saved from the bottom trusses of plants infected with *V. albo-atrum*and *V. dahliae* both in 1942 and 1944. The seeds were prepared by both the fermentation and soda processes.

Preliminary experiments showed that the surface of the seed could be sterilized by 5 minutes immersion in 1 in 3,000 mercuric chloride followed by washing in sterile water. The seeds were soaked In water for one hour before treatment. After sterilization, they were placed on slopes of Dox's agar. Three weeks later the plants were removed and pieces of hypocotyl and root were surface sterilized in calcium hypochlorite solution before being placed on Dox's agar. in no case did any *Verticillium* grow out from the tissues.

Table 2

Distribution of V. albo-atrum and V. dahliae

County	*V. albo-atrum*	*V. dahliae*
Bedfordshire	1	0
Buckingham	0	1
Cumberland .	1	0
Dorset . .	1	0
Essex . .	6	3
Gloucester .	0	1
Hertfordshire	6	0
Kent . .	0	2
Lancashire .	1	0
Sussex . .	1	2
Yorkshire .	2	0
Total . .	19	9

When seeds were placed on agar without surface sterilisation colonies of *Penicillium* and other fungi developed, but no *Verticillium*. It does not appear likely, therefore that the disease is transmitted

to any large extent through the seed. Nevertheless it is advisable not to save seed from houses in which the disease has occurred, unless care is taken to select healthy plants early in the season when the disease is easily recognised. Unless this precaution is taken, there is a risk that plants which have recovered from the disease may be used.

Distribution of the fungi

Further records have been made of the distribution of the two fungi. In Table 2 the records of the two years 1943 and 1944 have been combined. From this it will be seen that so far all records of *V. dahliae* have come from southern England.

3. Didymella Stem Rot of Tomato

ENID SHEARD

Throughout the year records were kept of such outbreaks of this disease as were brought to our notice. County advisers were asked to send specimens from nurseries on which they found it, and thanks are due to them for their co-operation. Plants infected with *Didymella* were received from one hundred and twelve nurseries in twenty four counties. Outbreaks were recorded in Kent (27) Sussex (18), Essex (11), Hertfordshire (10), Suffolk (6), Bedfordshire (5), Middlesex (5), Norfolk (5), Caernarvon (4), Devon (4), Isle of Wight (3), Yorkshire (2), Lincolnshire (2), Cambridgeshire (1), Denbigh (1), Dorset (1), Hants (1), Lancashire (1), Glamorgan (1), Northants (1), Pembroke (1), Staffordshire (1), Surrey (1). This list, of course, does not include all the outbreaks in the country during the year and it must be stated that in Kent, many of the outbreaks occurred on smallholdings with a very small area of glass. It does indicate, however, that the southern counties containing the largest acreages of glass were most severely affected. In many cases the disease had been present the year before and either the soil had been steamed, treated with formaldehyde or with proprietary sterilizers without obtaining any control. Infection appeared to be restricted to the bases of the stems, more rarely occurring below soil level, from the middle of March until the end of April. After that, plants were received bearing lesions higher up the stems and in all cases these appeared to have started where leaves had been removed or the stems otherwise damaged.

The information received on the amount of disease present on the different nurseries was not sufficient to draw any conclusions, nor was it possible to follow up each case to determine what was the loss from the disease at the end of the season.

In the Annual Report for 1943, it was stated that *D. lycopersici* was killed in pure culture by exposure to a temperature of 35° C. for seven days. In subsequent experiments, pure cultures of *D. lycopersici* were kept at 15° C. for three days to ensure that only actively growing cultures were subjected to the higher temperature. The cultures, measuring approximately 3 cm. in diameter were transferred to an incubator at 35°C. and a number of plates removed at 24 hourly intervals and returned to the 15°C. incubator. No growth took place at 35°C. but all the cultures kept at that temperature from one to four days began growing again when returned to 15°C. After five days at 35°C., half the cultures grew, and after six days, there was no growth. *Didymella* therefore, can survive for four days at 35°C. but after six days it is killed. These experiments refer only to the vegetative growth of the fungus in pure culture. It was hoped to investigate the reactions of the fungus in the tomato plant to high temperatures, but the necessary apparatus could not be obtained.

As the fungus spreads chiefly by pycnospores, it is important to know how long these spores can survive. Drops of spore suspensions in water were allowed to dry on slides. These were kept at room temperature in the dark and at daily intervals drops of tomato juice were placed on a number of slides which then were transferred to moist chambers and later examined for germination. The spores were found to be capable of germinating 15 to 17 days after being dried on the slides. At the same time pieces of stem tissue bearing pycnidia were removed from infected tomato plants and kept dry in glass tubes, at room temperature. Large numbers of spores emerged from the pycnidia immediately these were placed in water and after eleven months the spores from these pycnidia were still viable. From this it will be seen at that any piece of infected plant tissue which is missed in cleaning down the houses and in soil sterilization, presents a source of infection for next season's plants. The same is true of infected remains from outdoor tomatoes and from haulms left on rubbish heaps.

An attempt was made to determine if the type of growth of the tomato plant bore any relation to its susceptibility to the disease. The type of growth was controlled by growing plants of the same age in different sized pots and with different manurial treatments.

In small pots the plants soon became " hard," while those in 10 inch pots remained relatively " soft." The stems were then sprayed with a suspension of *Didymella* spores in water. The plants were destroyed by enemy action before the end of the experiment and it could not be repeated but up to the time they were destroyed, there was no appreciable difference in the numbers of " hard " and " soft " plants which had become infected.

4. Note on the Rotting of Heliotrope Cuttings by Corticium solani

ENID SHEARD.

No reference to *Corticium* on Heliotrope has occurred in the literature for the last twenty-seven years and it is possible that it never has been recorded before on this host.

During May of this year, a case of severe loss of Heliotrope cuttings was brought to our notice. The rooted cuttings were growing in steam sterilized soil in shallow wooden boxes. Brown lesions were present on the stems of some of the cuttings but in the majority of cases infection appeared to have started through the leaves, which bore irregular shaped, greyish-brown lesions where they were in contact with the soil. The diseased areas increased in size and spread inwards until all the leaves were rotted and the cutting died.

A species of *Corticium* was readily isolated from the rotted leaves and stems, which resembled *C. solani* in pure culture and which was pathogenic to tomato plants. It was concluded that the Heliotrope *Corticium* was *C. solani*.

The cause of the trouble was traced to the use of old, unsterilized boxes. A pale brown web of *Corticium* mycelium was found on the bottoms of the boxes and on the sides where the boxes had been placed close together and the wood was very wet. When new boxes were used, no further trouble occurred.

5. Virus Diseases

Susceptibility of lettuce to mosaic infection in relation to soil conditions.

I. W. SELMAN.

Indications have been obtained from work with the tomato, that susceptibility to virus infection may be related to the manurial and water levels obtaining in the soil. It was considered that lettuce was a suitable subject for further investigation on these lines, for it is only infected with the lettuce mosaic virus with some difficulty by mechanical inoculation. An experiment was therefore carried out with plants of Cheshunt Early Giant lettuce grown in ten inch pots containing a mixture of peat and calcareous sand. Soil treatments consisted of all combinations of three levels of nitrogen (as dried blood), three levels of phosphate (as superphosphate) and two levels of water (determined by frequency of watering). Full details of experimentation will be published in the Journal of Pomology Vol. 21.

Symptoms of infection began to appear eleven days after inoculation and consisted of slight vein-clearing followed by leaf crinkling and stunting. Mottling of the foliage was entirely absent under the conditions of this experiment. It was noted that the leaves of infected plants had a bitter, unpalatable taste.

Records were made of the numbers of plants in each treatment which developed symptoms of mosaic infection. These data are shown in Table 1.

Table 1

Number of lettuce plants showing mosaic symptoms
(8 plants inoculated in each treatment group)

Manures per pot		Water medium	Water high
Blood	Super		
1 gm.	1 gm.	1 out of 8	4 out of 8
1 gm.	4 gm.	5 ,,	5 ,,
1 gm.	16 gm.	3 ,,	6 ,,
3 gm.	1 gm.	2 ,,	8 ,,
3 gm.	4 gm.	5 ,,	7 ,,
3 gm.	16 gm.	3 ,,	6 ,,
9 gm.	1 gm.	4 ,,	3 ,,
9 gm.	4 gm.	8 ,,	8 ,,
9 gm.	16 gm.	6 ,,	6 ,,

High nitrogen and medium phosphate application thus gave plants which were 100% susceptible to infection although at the time of inoculation no difference in appearance could be detected between plants of this group and plants receiving low nitrogen, low phosphate and medium water, which were most resistant to infection.

From this and earlier work on the tomato, it may be suggested that resistance to virus infection may best be maintained by refraining from applying soluble fertilisers in excess of the immediate requirements of the plant. This factor may prove to be another virtue of the slow-acting organic type of fertilizer.

Infection with lettuce mosaic virus at the 4-6 leaf stage resulted in a mean reduction in fresh weight of 68% relative to the healthy controls.

6. Watering Frequency and the Effect of Mosaic on Tomato Plants

I. W. SELMAN.

In commercial work there has often been noted an apparent relation between the water supply and the severity or incidence of mosaic infection. Numerous difficulties arise in any investigation of this problem, thus, for example, temporary water shortage will certainly have different effects on plants differing in degrees of hardness, or again plants grown for long periods at different soil water contents may undergo structural adaptations to the special conditions under which they develop, thus making comparisons of treatments difficult to interpret. Weather factors also markedly interact with soil water supply in affecting plant growth. An attempt to gain some information on this complex problem has been made by varying the frequency of watering pot plants. One important practical objection to such an experiment is that when watering times are chosen arbitrarily, conditions suitable for maintaining balanced growth cannot easily be maintained, particularly in a house in which several treatments are being carried out. This was reflected in the rather low yields of fruit obtained from the healthy plants in all treatments. Nevertheless by this method it was possible to raise plants varying in degree of hardness.

Tomato plants vars. Ailsa Craig and Potentate, at the 8-9 leaf stage, were transferred to ten inch pots on 10th March and the pots divided into groups which were watered on an average daily, every two days or every four days. A similar amount of water was applied to each pot at any one watering time. During a growing and fruiting period of 18 weeks, watering frequencies were as follows :—

Water HIGH	x	120
Water MEDIUM	x	59
Water LOW	x	28

Top dressings containing dried blood and superphosphate, with or without sulphate of potash, were applied at intervals depending on watering frequency. In mid-season a feed was given after every ten waterings. The treatments were thus not simply related, but they did yield 3 types of plant varying in hardness, which could be demonstrated by dry matter determinations on the plant tissues.

On 27th March one half of the plants were inoculated with Tomato mosaic virus. Samples were taken at intervals following inoculation, of the third leaf from the apical bud and the dry matter determined by weighing before and after drying in an oven at 105°C. for 24 hours. The results are shown in Table 1.

Table 1

Percentage Dry Matter of 3rd Leaf (5 leaves per sample)

		Days after inoculation							
		2		7		12		17	
Var.	*Water*	*H*	*I*	*H*	*I*	*H*	*I*	*H*	*I*
A. Craig	Low	11.1	11.8	12.7	13.3	13.4	16.2	17.4	19.8
	Med.	10.7	10.7	11.7	12.0	11.8	12.7	13.5	16.5
	High	10.2	10.7	10.1	11.3	10.5	12.3	12.3	15.4
Potent.	Low	11.6	11.7	13.5	12.9	14.8	16.0	18.2	19.0
	Med.	10.5	11.7	12.0	11.3	11.8	13.2	13.7	16.6
	High	10.7	9.4	11.7	11.4	11.3	12.1	12.6	14.9

H—Uninoculated controls. I—Inoculated with tomato mosaic virus.

All the inoculated plants were showing symptoms of mosaic on the 17th day and it will be seen from Table 1 that the percentage dry matter has increased in the leaves of the infected plants (or the percentage water content has fallen). The differences in dry matter between H & I tended to be less in Potentate than in Ailsa Craig.

The three types of hardness shown by plants at the various water levels is manifested in the percentage dry matter of the leaves —a high dry matter content indicating a hard plant and vice versa. That these differences in plant water content were maintained during the season was shown by a dry matter determination carried out on 26th June on ripe fruit taken from the second and third trusses (see Table 2) Drying was carried out for 3 days at 120°C.

Table 2

Percentage Dry Matter of Ripe Fruit
(3 fruits per sample)

Var.	Water	H	I
A. Craig ...	Low	10.4	9.7
	Med.	7.2	7.9
	High	5.2	5.8
Potentate ...	Low	9.5	9.0
	Med.	7.6	8.5
	High	5.5	5.2

Thus although the percentage dry matter of the fruit was closely related to the watering frequency in all cases, the influence of mosaic infection seemed to depend on variety and watering level and thus differed in some cases from the effect recorded on the young leaves.

The plants were stopped at five trusses and the fruit weighed as it ripened. Enemy action prevented complete maturation of all the fruit on the 4th and 5th trusses, but those remaining were weighed green. Total fruit yield is recorded in Table 3. The values are the mean fruit yields of 20 plants in each treatment.

Table 3

Weight of Fruit per plant

5 Trusses

Var.	Water	H		I	
A. Craig ...	Low	1 lb.	5 oz.	1 lb.	1 oz.
	Med.	2	4½	1	15
	High	3	13½	3	6½
Potentate ...	Low	1	7½	1	3
	Med.	2	0	2	7
	High	4	6	3	9

With the possible exception of Potentate at the Medium water level there is little evidence of any interaction occurring between mosaic infection and watering frequency as they affect fruit yield. Under the conditions of this experiment it must be concluded that there is little evidence to show that mosaic infection brings about a greater reduction in fruit yield under one watering frequency than it does under another. This conclusion may still not apply to the influence of mosaic infection on fruiting, under conditions of severe but temporary fluctuations in water supply, which certainly produce very serious effects in the growth of mosaic-infected plants at certain stages of development.

7. Observations on the Tomato Spotted Wilt Virus Disease of the Arum Lily

I. W. SELMAN.

In 1934 workers in both England and America were able to demonstrate that a common mosaic-like disease of the Arum (*Calla* or *Zantedeschia*) was caused by the virus that produces the spotted wilt disease of the tomato. Blooms of affected plants are frequently water-soaked, distorted and fail to mature showing premature browning and decay. The foliage may be variously marked with

yellowy-green spots or streaks or both. Little or no experimental work has been done on the disease in arums, but it has generally been assumed that it may be spread by the insect thrips, although controlled transmission to arum does not seem to have been demonstrated.

Two flowering corms of Arum were received from a commercial nursery in April 1942, growing side by side in a single ten inch pot. One plant was healthy and the other showed typical flower and leaf symptoms of spotted wilt, and the disease was confirmed by transference to tomato seedlings. The pot was mulched with short stable manure, top-dressed regularly and watered freely. Four months later, new leaves appearing on the diseased plant were apparently normal and free from mosaic-like markings. In April 1943 blooms were present on both plants and flowers of the diseased plant were perfect in colour and shape and generally indistinguishable from those of the healthy plant. Of six leaves on the diseased plant, only one showed the yellowish markings associated with spotted wilt.

The plants were separated at this time, potted up and grown on in the same house. For six months during 1944, the plants were not fumigated, following bomb damage to the house. Although the healthy plant and its offsets have thus been in close proximity to the diseased plant for over three years, they still retain their freedom from disease symptoms. Offsets removed from the diseased plant in December 1944 showed no sign of disease and still appear clean five months later.

The ability of growers to produce normal bloom on diseased stock has frequently been noted and renders very difficult the elimination of spotted wilt from the tomato crop. Neither is this condition confined to the arum crop. Dahlias and chrysanthemums are other common sources of this virus which growers are loth to destroy, so long as marketable blooms are obtainable from diseased plants. To safeguard the tomato crop in war time, it has been found necessary in some counties for the W.A.E.C. to exercise its powers to deal with the problem. In peacetime, legislative measures might prove hard to enforce and indeed would be difficult to justify in many cases. All that can be done at present is to direct the attention of growers of mixed crops to the prevalence and potential danger of spotted wilt in arums, dahlias and chrysanthemums in particular, and in building up new stocks to propagate only from plants free from the disease. Where old, and possibly diseased, stocks are maintained, growers are urged to carry out routine fumigations with nicotine shreds (2 ozs./1,000 cu. ft.) to destroy the carrier insect thrips, thereby protecting tomatoes or other susceptible species which, through shortage of space, may have to be housed with diseased stock.

ANIMAL PESTS.

1. Red Spider-mite (*Tetranychus telarius* L.)

E. R. SPEYER and W. J. PARR.

Distribution of infested plants in Tomato Houses

Further information upon the distribution of infested plants in the tomato houses at the Cheshunt Station early in the growing season has been obtained (see Annual Report, 1943, p. 56).

The mite was first observed upon a small number of plants in the propagating houses in March—upon these the red female mites laid only a few scattered eggs and appeared to leave the plants after so doing. After planting out in House 4 on March 20th observation was kept upon three of these plants. Upon two of them the mites when adult left the plants without depositing eggs. In the case of the third plant, a large number of young stages were present on May 5th, but were confined to the leaf upon the one leaflet of which the eggs had originally been deposited. In June the infestation had spread to a number of plants in the immediate vicinity. This is consistent with Lloyd's observations (Ann. Rep. 1921, p. 42) which indicated that the majority of adult mites of the first and second generations leave the plants, and enter a short period of hibernation. It may be that the mites which are first to leave their winter quarters may also return for sometime into hibernation after the deposition of only a few of their eggs.

On April 4th a survey of selected plots in House 5 was made. Upon the east side, feeding marks of the mites were found upon 9 plants out of the 200 examined. Six of these plants were situated in the first three rows nearest to the central path, and eggs had been deposited upon leaflets of five of them, but only in one case was the parent female (of the red hibernating form) present. Upon the leaflets of the remaining three plants situated in rows between the purlins and the gutters no eggs had been deposited and it is possible that the feeding marks had been made when the plants were still in the propagating house, and that the mites had left them before they had been planted out.

On the west side, 9 plants out of 36 in the row nearest to the path, and one out of a similar number in the second row had feeding marks, and in one case a red female mite with eggs, upon the leaflets. No trace of infestation was found upon 80 plants situated in the remaining rows towards the gutter.

Additional support is therefore given to the contention that plants in the rows beneath the ridge are the first to be invaded by mites as they come out of hibernation, but centres of infestation may arise anywhere from plants which already have mites upon them in the propagating house. The dispersal of mites to surrounding plants appears to be slow until after the middle of May.

2. Fumigation of Lettuce with Hydrogen cyanide.

From January to March a series of fumigations was carried out in isolated glasshouses ranging from 500 to 5,000 cubic feet capacity to test the effect of hydrocyanic acid gas upon some species of Aphides injurious to lettuce and upon Chrysanthemum "black fly." For the generation of the gas, a proprietary "cyanide" powder was distributed upon the paths shortly after sunset and the ventilators were opened at dawn on the following morning. It was calculated that one ounce of the powder should give off a volume of gas equivalent to that generated when two-fifths ounce sodium cyanide was decomposed by 30% sulphuric acid, as employed in the "jar" method of fumigation.

In the series of 11 fumigations the dosages given ranged from one-quarter to three-quarters ounce of the powder (equivalent to from one-tenth to one-third ounce sodium cyanide) to the 1,000 cubic feet of space. Temperatures recorded throughout showed a mean of 54°F. with mean minimum 49°F. and mean maximum 59°F.

In a few of the fumigations, the path of the house was moistened shortly before distribution of the powder upon it; and when in one instance a dosage of three-quarters ounce per 1,000 cubic feet space was given, the odour of hydrogen cyanide was perceptible for a period of at least three days, even though the ventilators remained open during the daytime, a contingency which was very undersirable.

The lettuce plants subjected to treatment were Cheshunt Early Giant planted out in the ground in November, 1943 and cropped in late March 1944, plants of the same variety just beginning to heart in pots placed upon staging, and seedlings of Cheshunt Early Ball ready for planting but still in the seed boxes.

The Aphides comprised a natural infestation by *Macrosiphum gei Koch* (a dark red variety) and artificially induced infestations [see III (a)] of the normal green form of this species, and of *Myzus ornatus* Laing upon the plants in the ground: the colonies of these insects were, as far as it was possible to judge, entirely free of Hymenopterous parasites. The pot-plants had natural infestations of the two species mentioned and of *Myzus solani* Kalt, [see III (b)]; the insects were comparatively free of parasites during the earlier fumigations, but later became heavily parasitised by Braconids, which were unaffected by the gas.

Chrysanthemum pot-plants with strong stem infestation by *Macrosiphoniella sandborni* Gill, were placed upon staging and upon the ground.

In addition, it was considered desirable to observe the effect of the gas upon young tomato plants (variety Potentate) about 8 inches high in "60" size pots: these were placed both upon staging and upon the ground during fumigations.

(1) Effect upon the plants

(*a*) Lettuce :—in no fumigation was the slightest trace of injury observed, whether the plants were young, ready for cropping, and either wet or comparatively dry at the root at the time of fumigation, even when dosages of three-quarters ounce powder (equivalent to one-quarter ounce sodium cyanide) per 1,000 cubic feet space were given.

(*b*) Tomato :—the young pot plants, if drooping for lack of moisture at the root, were not injured by dosages up to one-half ounce powder per 1,000 cubic feet space. At the latter dosage, soft-grown plants, if moist at the root, developed slight leaf-curl and traces of yellow spotting upon the foliage. At a dosage of three-quarters ounce powder per 1,000 cubic feet space, hard grown plants, lacking moisture at the root, escaped injury, but if moist at the root, some leaf-curl and foliage-scorch developed. Soft-grown plants lacking moisture at the root showed some leaf-curl but no foliage scorch, but if wet at the root, were severely injured. In cases in which injury was caused, this was more pronounced upon plants standing in their pots, on the ground than upon those placed on staging. In a fumigation carried out by the " jar " method, with a dosage of one-quarter ounce sodium cyanide per 1,000 cubic feet space, no permanent injury was sustained, provided that the plants were drooping for lack of moisture at the root at the time of fumigation.

(*c*) Chrysanthemum :—slight leaf-scorch was observed at a dosage of three-quarters ounce powder per 1,000 cubic feet space, when the pots were well watered immediately prior to fumigation.

(2) Effect upon Aphides

No appreciable differences in the lethal effect of the gas upon the several species infesting Lettuce was observed, but the mature alate and apterous forms of Chrysanthemum Black-fly appeared to be more resistant.

In all species the 4th instar nymphs (whether of apterous or alate forms) and adults (5th instar) were much more resistant than nymphs of the first three instars. At dosages of less than one-third ounce powder per 1,000 cubic feet space ; none of the species were materially affected. When one-third to one-half ounce powder (equivalent to one-eight to one-fifth ounce sodium cyanide) was used, infestations were greatly reduced, provided that the glass-house was not very leaky, in spite of the recovery of a very high proportion of 4th instar nymphs and adults.

With dosages of three-quarters ounce powder (equivalent to one-quarter ounce sodium cyanide) per 1,000 cubic feet space, control was obtained in both tight and leaky houses although here again varying proportions of the older nymphs and of the adults survived.

That such a measure of control was obtained is explained by the fact that the younger nymphs, susceptible to destruction by the gas, far out-numbered the older ones in the colonies; moreover, during the comparatively long period of time over which the adults produce their young their actual rate of reproduction was slow at the prevailing temperatures.

It was considered possible that small quantities of gas adsorbed upon the leaf-surface or dissolved in moisture on it might have led to the death of the insects after a fumigation, but individual insects which showed signs of recovery after fumigation were kept upon uninfested plants which had also been fumigated, and they recovered completely and produced their young normally.

It is noteworthy that all these species of Aphides showed a far higher degree of resistance to hydrogen cyanide than had been previously anticipated. Greenhouse White-fly (*Trialeurodes vaporariorum* Westw.) was introduced into the houses on tomato plants in a number of the fumigations, and a very high (85%—95%) proportion of the adults were killed when dosages hardly sufficient to affect the Aphides to an appreciable extent were employed.

(3) Conclusions and Recommendations

Hydrogen cyanide is a fumigant eminently suitable for the control of Aphid infestations upon lettuce, a plant which will not suffer injury from comparatively high concentration of the gas in glasshouses. The distribution upon the paths of the houses of powders, from which the gas is liberated, is a convenient method of fumigation, but directions given by the manufacturer as to whether the paths should be dry or moist, according to the proprietary brand obtained, must be strictly adhered to.

To obtain control of Aphid infestations upon lettuce in isolated glasshouses it is necessary to use a quantity of powder sufficient to liberate a volume of gas equivalent to that evolved from one-quarter ounce sodium cyanide to every 1,000 cubic feet of space. In blocks of houses, the dosage should be reduced so as to be equivalent to about one-fifth ounce sodium cyanide per 1,000 cubic feet space, because the relative area of absorptive surface and loss through leakage is less in blocks of houses than in isolated ones.

The presence of living adult Aphides upon the plants after a fumigation does not mean that the treatment has been unsuccessful. The rate of reproduction of the insects is slow until heat is put on to hasten the crop to maturity and the comparatively short period of time remaining until the crop is harvested is insufficient to enable the surviving Aphides to increase to any serious extent, especially when parasites, which are unaffected by the gas, are present. Colonies of the insects are rarely free from parasites.

Should, however, an increase occur, the low cost of the treatment allows of a second fumigation. The method has advantages over the more costly use of Nicotine shreds, from which the smoke produced tends to remain above the level of low-growing plants.

Chrysanthemum Black-fly being more resistant to hydrogen cyanide than Aphides affecting lettuce, and its colonies being situated usually at some distance above ground-level, better control of this pest is obtained from the use of nicotine shreds than from cyanide fumigation.

Tomato plants while still in the progagating house are subject to attack by Aphides, and adult White-flies which will later start infestations upon the main crop are often present upon the foliage. Provided that the plants are just drooping for lack of moisture at the root, " cyanide " fumigation may be resorted to without risk of appreciable injury to the foliage. Using " cyanide " powders, a dosage equivalent to one-eighth to one-sixth ounce sodium cyanide per 1,000 cubic feet space is sufficient to destroy the white-flies and greatly reduce the number of Aphides upon the plants. Such fumigations should be carried out shortly before the plants are ready for setting out in the ground : they must be started shortly after sunset, and the doors and ventilators opened at sunrise next morning.

3. Nomenclature of Aphididae.

(*a*) *Macrosiphum gei* Koch (1855) :—the question as to whether *M. gei* Koch and *M. solanifolii* Ashmead (1882) are separate and distinct species has long been in dispute.

Hille Ris Lambers (1939) treats of them as distinct, and separates the one from the other upon differences in the number of setae present respectively upon the cauda, 8th abdominal tergite, and both anterior and posterior regions of the subgenital plate.

He claims priority for the name *M. euphorbiae* Thomas (1878) over *solanifolii* Ashmd., but in referring to the account given by Hottes and Frison (1931) of *M. gei* Koch, Ris Lambers (loc. cit.) does not draw attention to the statement made by these authors to the effect that Thomas' co-types in the Illinois Museum are " in very poor condition." It would hardly be possible to determine from such specimens as to whether they are identical with *gei* Koch, the type specimen of which is no longer in existence or whether *solanifolii* Ashmd. is conspecific with *euphorbiae* Thomas.

There is nothing in the brief description given by the earlier authors which would serve to separate the two species either from one another or from other species of the genus.

Lambers (1939) also states that *M. gei* Koch occurs upon Geum and Umbelliferous plants, and that " euphorbiae " Thomas is " pantophagous."

Amongst both alatae collected from, and in some instances bred upon, glasshouse and other plants, there occurred a very considerable number of specimens in which the characteristics of "gei" and "solanifolii," as specified and figured by Hille Ris Lambers (1939), were combined. It has therefore been concluded that these particular characteristics are not constant, and that, for the present, it is best to regard *M. gei* Koch and *M. solanifolii* Ashmd. as synonymous.

The problem, which is of some importance in research upon the transmission of virus diseases by these insects, is under further investigation.

References

Ashmead, W. H. 1882, Canadian Entomologist XIV p. 92.

Hille Ris Lambers, 1939, Temminkia IV, Leiden p. 83.

Hottes, F. C. and Frison, T. H., 1931, Illinios, Nat. Hist. Survey Bull. XIX, art. 3, p. 306.

Thomas, C. A., 1878. Bull. Illinios State Lab. Nat. Hist. I. No. 2, p. 6.

(*b*) *Myzus* Passerini (1860) :—Mordvilko (1914) raised a genus Aulacorthum to which a number of species, including *solani* Kalt. and *circumflexus* Buckt., previously placed in the genus Myzus have been transferred by several authors.

It was considered desirable to make an examination of *Myzus cerasi* F., type of this genus, collected from Cherry in July 1942. In respect of the proportionate length of cauda to cornicle, the alatae were found to be referable to Myzus and apterae to Aulacorthum, and vice versa in respect of striation or reticulation in the distal portion of the cornicle. Other characteristics given by Mordvilko for the separation of the two genera either depend upon judgment of the individual observer or appear to be of doubtful constancy even within the species. The validity of the genus Aulacorthum therefore appears to be questionable. A characteristic which was at first thought to be of value in separating the two genera lay in the possession by *Myzus cerasi* F., in all instars of both alatae and apterae, of papillae placed rarely upon the occiput of the head, commonly upon the pronotum, and medianly upon the 7th abdominal tergite ; but the development of these papillae was often asymmetrical and generally erratic, and it is possible to conceive of specimens in which they might be entirely wanting.

Myzus solani Kalt—the species *convolvuli Kalt., pseudosolani* Theob. and many of Theobald's species are considered by Hille Ris Lambers (1933) to be synonymous with *solani* Kalt. Doubtless this is correct, as no author appears to have described characteristics by which these species can with any degree of certainty be separated.

References

Hille Ris Lambers, 1933, Stylops 2, pp. 169-176. Mordvilko, A. 1914, Faune d. l. Russie. Ins. Hemipt. I livr. 1.

(*c*) An interesting Aphid on Chrysanthemum. In November, 1942 an Aphid which might be indentical with a North American species described under the name *Rhopalosiphum violae* by Pergande in 1900, and more recently included in the genus Micromyzus V. d. Goot, was found to be breeding upon Chrysanthemum at the Cheshunt Station. Essig (1935) has named two other species, *M. oliveri* and *M. alliumcepa* (from Onion), which he separates from *vioae Perg.* and from one another solely upon differences in the numbers of rhinaria present upon the antennal joints, a character which is very obviously inconstant within the species amongst Aphididae.

The insect upon Chrysanthemum appears also to be identical with one recently recorded as injurious to Onion in England. Amongst the alatae obtained, there is wide fluctuation in the " cloudiness " along the wing-veins, and in some specimens this characteristic is entirely wanting. Being the only one of any significance which has been used to separate Micromyzus from Myzus and allied genera, it becomes doubtful as to whether the former genus is valid.

Reference.—Essig, E.O., 1935, Pan-Pacific Entomologist XI, No. 4.

4. Tomato Moth (*Polia oleracea* L.)

(*i*) Increase at the Cheshunt Station :—The number of moths trapped in jars baited with ale, powdered malt extract and Sodium fluoride in the experimental houses between 20th January and 16th May was 550. The number trapped in previous years over approximately the same period has been 133 in 1941, 281 in 1942, and 348 in 1943.

These figures indicate that the pest is increasing, in spite of annual spraying with lead arsenate and trapping of the moths from January to the middle of May and again from the middle of August until the beginning of October. The increase appears to be due to moths which enter the houses from outside in June and July. For glasshouses in more isolated districts, the curtailed period of trapping may be permissable, but in larger areas in which the pest has long been established, trapping throughout the growing season, as advocated by Lloyd in 1920, appears to be essential in order to prevent such increase.

(*ii*) Effect of " D.D.T." upon the Eggs :—On June 10th, egg masses, which had been deposited upon muslin respectively 2, 4 and 7 days previously, were dusted with a powder containing 5% " D.D.T." Two masses at each age were treated. Forty-seven caterpillars hatched successfully from a total of 228 eggs : a mortality of 79% was therefore obtained. The shells of the remaining 181 eggs were perforated by the caterpillars, which succumbed in the process of hatching. The degree of mortality obtained was dependent upon the depth of the individual egg-mass treated, and not upon the age of the eggs at the time of treatment.

Untreated eggs hatched from 8 to 10 days after deposition with a natural mortality of less than 1%. A proprietary "D.D.T." emulsion, diluted one part in 200 parts water and sprayed on to egg-masses respectively 4, 6, and 9 days after deposition, gave a total mortality: the three egg-masses treated contained in all 395 eggs.

In July this emulsion at dilution of 1 in 800, 1 in 600, and 1 in 400 parts water respectively, was applied to egg-masses soon after their deposition upon tomato leaflets. No caterpillars hatched from the eggs subsequently. The eggs were kept under close observation and dissections were made periodically. The following observations were recorded:—

The eggs developed normally until the caterpillars were fully formed and capable of movement within the shell upon the 6th or 7th day after deposition. After this the caterpillars in the eggs situated upon the top, at the sides, and nearer to the surface of the egg-masses became feeble and were not strong enough to eat their way out through the shell. The caterpillars in some of the eggs deeper within or upon the floor of the mass adjoining the leaf surface succeeded in perforating the egg-shell, but after devouring the piece of excised shell, as is their habit, they died usually with the head projecting through the hole and the remainder of the body still within the shell.

It was observed, both in the case of treated and untreated eggs that the change of colour from yellow to purple, upon the 5th and 6th day after deposition, was due, not to air entering the shell, but to the appearance of a granular fluid, probably a product of excretion, voided by the developing larva. Air does not gain access to the interior of the shell until it has actually been perforated by the caterpillar in the process of hatching.

It is concluded that "D.D.T." in emulsion penetrates the egg-shell in quantities insufficient to prevent development of the egg, but sufficient to enfeeble the caterpillar to a degree which prevents it from perforating the shell at the time of hatching. The caterpillars in eggs situated deeper within or upon the floor of the mass are able to perforate the shell, but die in the process of hatching.

5. White-fly (*Trialeurodes vaporariorum* Westwd.)

Fumigation with Tetrachlorethane.

A number of reports, especially from small-scale growers, have been received indicating that results obtained from fumigation with tetrachlorethane and proprietary liquid fumigants, composed mainly if not entirely of this compound, have been unsatisfactory.

In practically every case it has been ascertained that the quantity of fumigant used was inadequate.

Observations recorded from the experimental houses and especially the parasite breeding house at Cheshunt, in addition to an isolated glasshouse of 2,500 cubic feet capacity at Hoddesdon have shown conclusively that 8 fluid ounces per 1,000 cubic feet space is the mimimum quantity which will effect any permanent control of the pest, and that in leaky houses 10 fluid ounces (=½ pint) is necessary. It is also essential, unless White-fly parasite has been introduced, to give a second fumigation, using the same amount of fumigant, not less than 2 and not more than 3 weeks, according to prevailing temperatures, after the first. The liquid must be poured upon the path of the glasshouse as early as possible in the afternoon or evening, and the house kept closed for as long as possible on the following day. So long as direct sunlight does not fall upon the plants while the vapour of the fumigant is in the atmosphere, any risk of injury to tomato plants, which should be moist at the root when fumigated, is very remote.

An amount of 5 fluid ounces per 1,000 cubic feet space may occasionally give a good measure of control, but cannot be relied upon, and if unsuccessful a considerable amount of the comparatively costly fumigant will have been wasted.

It has recently been discovered that adult flies which lie motionless and apparently dead upon foliage and upon the ground for at least two days after a fumigation may subsequently recover. On the other hand, some may recover partially and die subsequently. A true estimate of the proportion of adult flies killed can be obtained only if they are kept under observation for a period of 6 days after a fumigation.

On 13th September a fumigation was carried out in an isolated leaky house of 2,500 cubic feet capacity, with a dosage of 10 fluid ounces per 1,000 cubic feet space: temperature ranged from 56°F. to 62°F. over the 16 hours duration of the fumigation. On the second day after, 368 motionless flies were collected from the house, and during the following four days, 16 flies recovered completely, and 29 partially recovered but eventually succumbed.

Owing to the fact that in previous fumigations detailed observations had only been recorded for two or three days following each, the apparent high rate (up to 95%) of mortality amongst the adult flies obtained, when only 2 to 2½ fluid ounces per 1,000 cubic feet space was employed, proves to be entirely inaccurate.

It is certain that at any rate the later " scale " stages of white-fly are not all killed by dosages of less than 10 fluid ounces per 1,000 cubic feet space, even in tight houses, and the eggs of the insect are not affected by dosages which it is possible to employ with safety upon growing plants.

At a dosage of 5 fluid ounces per 1,000 cubic feet space, however, the proportion of adult flies killed is very high, and if these are detected on tomato plants in progagating houses early in the growing season, when they are laying but few eggs, a fumigation using this amount is of great value.

It is worthy of note that after a fumigation with this dosage carried out on 28th March, 1944 (duration 17 hours, temperature range 56-60°F.)., one out of 126 adult flies recovered during the ensuing two days, but out of 126 adults of the White-fly parasite (*Encarsia formosa*, Gahan), 125 recovered completely within this period, after temporary anaesthesis.

6. Leaf-miners of Tomato (*Liriomyza* spp.)

In 1938 some notes upon a Leaf-miner of Tomato received from the Channel Islands were published (Speyer 1938); at the time it was assumed that the insects bred from this material were of the species *Liriomyza solani* Macq. After a study of an allied species, *L. strigata* Macq., which has in recent years become a pest of Tomato seedlings in Hertfordshire glasshouses during January and February, specimens fortunately preserved from the Channel Islands material have been submitted to Dr. F. I. van Emden (Imperial Institute of Entomology) for determination. To this authority grateful thanks are proferred for the valuable information which he has imparted, and for his determination also of leaf-miners collected recently from Tomato and other glasshouse plants. In the material from the Channel Islands both species may have been present, but *L. strigata* was the predominant one.

It now becomes desirable to review previous records :—

(1) Specimens obtained from Tomato upon a nursery at Lower Edmonton, Middlesex, in July 1926 (Speyer 1926) cannot now be traced, but it is practically certain, from extant photographs of the mined leaves, that the insect here concerned was the Chrysanthemum Leaf-miner (*Phytomyza atricornis* Mg.) Upon removal of weeds amongst which Sow-thistle was predominant, growing in profusion amongst the Tomato plants, no subsequent infestation was recorded.

(2) The miner which occurred plentifully during the summer months of 1935 and 1936 (Speyer 1936) upon another nursery at Edmonton was *L. solani* Macq. The determination made by the late F. W. Edwards has been confirmed.

In 1937 the nursery, which was situated upon badly drained land, was abandoned.

(3) Since 1935 larval mines, always in small numbers, have been observed annually, and principally during late summer, upon

Tomato foliage at the Cheshunt Station : from the configuration of the mines, the species here involved has almost certainly been *L. strigata* Macq.

(4) The miner first recorded in February, 1940 as injurious to Tomato seedlings upon a nursery at Cheshunt and now prevalent upon a number of nurseries in the Lea Valley throughout the growing season is *L. strigata* Macq. The larvae of this species were also found mining in the leaves of lettuce upon a nursery at Wormley on 21st December, 1933 : adult flies emerged from the pupae obtained from them during January, 1944.*

The increase of *L. strigata* upon commercial nurseries in the Lea Valley district coincided with changes in cultural methods adopted by growers of Tomato plants. The raising of Tomatoes, particularly of the variety Potentate, with a soft type of foliage has been favourable to reproduction of this insect, which prefers plants with succulent leaves for purposes of oviposition. Application of increased quantities of water to the soil, in which the larvae pupate, has also favoured the successful emergence of flies from the pupae, which are adversely affected by lack of moisture. The attacks which now occur during late summer appear also to be due to *L. strigata*.

(a) Habits of Liriomyza strigata Macq.

During the winter months the insect may continue to breed in the leaves of lettuce, but in unheated glasshouses the pupae of the previous generation lie dormant in the soil. If the soil has been dug over or trenched, these pupae will have been buried to considerable depths, but it is known that Agromyzid flies have no difficulty in " worming " their way to the surface as soon as they emerge from the pupae.

Some 3 or 4 weeks after heat has been put on in propagating houses, the adult flies begin to emerge from pupae contained in the soil beneath the staging. All the flies do not emerge together, and it has been observed that this first flight of the year in January or February, may be extended over a period of from 3 to 4 weeks.

The fly is active but of secretive habit, and is therefore but seldom seen : only one specimen was actually observed in glasshouses in which the infestation of plants was very considerable during the January both of 1943 and 1944.

Like other species of Liriomyza and allied genera, the female fly sinks pits by means of its ovipositor into the surface of the foliage, and feeds upon the sap exuding from the punctures. Upon seedlings of Tomato (and Cucumber also), *L. strigata* usually feeds

*Chrysanthemum Leaf-miner (*Phytomyza atricornis* Mg.) was recorded upon Lettuce at Broxbourne in October, and Cheshunt in November, 1943. The larvae pupated within their mines, and pupae from the latter locality emerged early in December.

on the under surface of the cotyledons; the punctures occur less often upon the young rough leaves, but here they are more conspicuous because they are made upon the upper surface.

It would appear that the fly makes use of one cotyledon of a seedling for the purpose of feeding and the other for that of oviposition.

When Tomato seedlings are available for it, the fly inserts its eggs deeply into the under surface of the cotyledons. Only one egg is laid in a cotyledon, usually in the distal portion, but seldom near the edge. When young rough leaves or older foliage of an unsuitable nature were provided, the fly deposited several eggs in punctures made upon the upper surface of the same rough leaf, and in once case a female ridded itself of 5 or 6 eggs actually upon the surface of a leaflet. In the latter instance, at any rate, the larvae perished soon after hatching from the eggs. Except under such abnormal circumstances neither eggs nor young larvae were ever found to be present in the rough leaves of tomato plants less than 2 months old from the date of germination.

Eggs of this fly were very rarely met with, and it has been concluded that the period of incubation is extremely short, possibly a matter of a few hours, if, indeed, the insect may not sometimes actually be viviparous.

Two normally laid eggs obtained were white and oval in shape, each with a length of 0.25 mm. and a diameter at the centre of 0.13 mm. The dimensions are large for the size of the parent, and indicate that the complement of eggs laid by a single fly is not large.

Soon after hatching within the tissues of the cotyledon, the white larva (about 0.5 mm. in length, and 0.13 mm. in diameter) begins to feed deep in the collenchyma, so that for some time its presence can only be detected in material cleared for microscopic examination. The mine follows no definite course, and after devouring a portion of the collenchyma, the larva passes through the cotyledon stalk and main stem into the other cotyledon of the seedling.

In so doing considerable caution appears to be exercised by the larva in order to avoid undue disturbance of the tissues, which might result in destruction of the plant. Occasionally a young seedling may accidentally be destroyed, in which case the larva also succumbs, as at no stage of development is it able to penetrate the plant tissues once it has left, or been removed from, the mine. Having eaten away the collenchyma of the second cotyledon, the larva may return in the mine to feed upon any tissue which may have been left in the first, and then ascends the stem, just beneath the cambium layer, to the rough leaves. Here it behaves in the same manner as it did in the cotyledons, and if the first leaf is not large enough to provide food sufficient for the completion of the larval life, the stem between the leaves is again traversed, and

the mine continued in that opposite. The actual growing point of the seedlings is not entered. It is at this time that the seedling is most liable to collapse. Through removal of the collenchyma, the plant is unable to avail itself of phosphate taken up by the roots, and additional loss of the greater portion of the parenchyma in the rough leaves brings assimilation practically to a standstill.

The larva treats the seedling as a single entity, and may return in its mine from the rough leaves back to the cotyledons in order to obtain food sufficient for the completion of its development, though such an occurrence is rare.

Sometimes two larvae may occur in a single seedling, an egg having previously been inserted into each of the two cotyledons, probably by two different flies. In this event the larvae occupy opposite sides of the plant, so that their respective mines do not interfere with one another.

When full-fed, and still of a white colour*, the larva has a length of 3.0 mm., sometimes rather more, and a diameter of 0.70 mm. to 1.0 mm. Measurements taken of the " mouth-hook " of larvae at various stages of development showed lengths of 24-27μ rarely 50μ, frequently 72μ and less often 78-86μ. By application of Dyar's law, it is indicated that there are usually only two larval instars, but that in some larvae two ecdyses may take place before the final one to the pupal instar. The larva appears always to undergo the first ecdysis in the cotyledons before ascending the stem to the rough leaves.

The time occupied by the larva while mining in the cotyledons and rough leaves respectively was not determined with any degree of accuracy, but the amount of food obtained in the former is certainly insufficient to enable it to complete its development. It was estimated that not more than 4 days were spent in the cotyledons, and not more than 3 days in the rough leaves, the whole larval life occupying a period of not less than 5 and not more than 8 days.

When full-fed, the larva escapes from the mine through a slit-like exit-hole, and drops to the soil-surface beneath which it pupates.

During the propagation of tomato plants, the majority of pupae may be removed from the houses in the soil of the seed-boxes as the seedlings are potted up, but a small number may be contained in the soil beneath the staging, the larvae having dropped from leaves overhanging the sides of the boxes.

The pupae are very sensitive to lack of moisture, and are liable to perish in the discarded soil of the seed-boxes, unless this soil is heaped outside and kept moist by rain. The subsequent emergence of flies from the pupae will tend to increase the

* The anterior portion of the larvae of *L. solani* is described by Cohen (1938) as being of a bright orange colour.

population of the insect upon weeds in the vicinity of the glass-houses and provide a source of infestation upon tomatoes with a soft type of foliage during the summer months. The flies emerge from the comparatively small number of pupae left in the soil beneath the staging towards the end of February, the duration of the pupal period in the early months of the year probably being from 6 to 8 weeks. They insert their eggs into the leaflets of plants now ready to be planted out, or recently planted out in the ground, usually selecting those upon the fourth or fifth leaves below the growing point of the plant, or quite low down upon rather older plants. Only one egg is inserted into a leaflet, (usually a terminal or distal one) and often, at least, the fly confines itself to the deposition of a single egg on a whole leaf.

The larval mine tends at first to follow a course immediately above the mid-rib of the leaflet, and the larva returns to this repeatedly from short side-branches but in older leaflets the course of the mine is extremely variable. The diameter of the mine is continually increased and so becomes several times greater than that of the larva itself.

Having passed into the leaf-stalk, and thence into an adjoining leaflet, yet a third may be entered, so that the mine of a single larva may extend into three leaflets. When nearly full-grown the larva spends a considerable time in the leaf-stalk, in which it is exceedingly difficult to detect, but does not appear to feed upon the tissues. When mining in the foliage of older plants the larva can obtain sufficient food for its development from a single leaflet.

During the summer months the duration of the pupal instar is reduced to a period of a fortnight to three weeks, and in July and August severe infestation may develop upon tomato plants with a soft type of foliage. In moist atmosphere the larvae after leaving their mines, pupate upon the under surface of the leaflets, from which, however, they are readily dislodged and fall to the ground.

Unlike *L. solani*, in which the pupae of the late summer generations overwinter and do not emerge as flies until the following May, *L. strigata* breeds throughout the year in glasshouses, lettuce constituting a winter host for the insect.

(b) Infestation upon Seedlings of Tomato

The habits of Leaf-miners, the eggs and larvae of which are partially hidden from view within the plant tissues, are not easy to observe in detail, and an attempt has been made to gather the more important facts, outlined above, concerning *L. strigata*, from material collected and simple experiments carried out upon a commercial nursery at Cheshunt in the early months of 1943 and 1944.

In both these years the main bulk of seed had been sown in boxes on 11th December of the previous year, but additional sowings were made at intervals between that date and the first week in January. In both years, again, the first signs of infestation upon the seedlings was observed during the first week of January.

Owing to their shy and secretive habit, the adult flies remained to all intents and purposes unobserved, but ample evidence of their presence in the propagating houses was forthcoming from the feeding marks which the females had made upon the cotyledons and to a far lesser degree upon the rough leaves. Although the marks were plentiful upon the cotyledons on the 7th day, none were observed up to the 5th day after germination of the seedlings. Upon the 7th day, the newly hatched larvae had already begun to mine in the tissues of the cotyledons. As this, and a great deal of other evidence, shows that the period of incubation is extremely short, (if indeed the insect may not sometimes actually be viviparous), it may be concluded that the fly did not deposit eggs in the plants before they had been above ground for at least 5 days.

Cotyledons with feeding marks or containing larval mines (or portions of them) were collected from some 2,000 seedlings (sown on 1st January, 1944) on the 7th day after germination, and both cotyledons thus affected and rough leaves containing portions of larval mines from some 1,350 seedlings (sown on 11th December, 1943) upon the 24th day after germination.

A microscopic examination of the material gave the results set out in Table 1.

Table 1. Examined 11–13/1/1944.

Seedlings	*Days after germination*		
	7	24	
Total number examined (approx.)	2000	1350	
Number infested (apparent) ...	6	15	
% infestation (apparent)	0.3	1.1	
Number with feeding marks or mines			
in one cotyledon	18	0	
in both cotyledons	2	15	
in one rough leaf	—	2	
in both rough leaves ...	—	13	
	Cotyledons	*Cotyledons*	*Rough leaves*
Number with feeding marks ...	12	—	—
Number with a mine or portion of one containing a larva	6	0	9
Number vacant	4	30	12
% containing a larva	60	0	44
Number of larvae present ...	6	0	9
Number of completed mines vacant	0	0	6

The figures and percentages given for the number of seedlings infested is only apparent, because, owing to difficulty of detection, no account could be taken of cotyledons in which eggs or very young larvae were present. When smaller numbers of seedlings, all the cotyledons of which could be subjected to microscopic examination were dealt with, a percentage infestation of 14 was recorded (see Table 2).

From Table 1 the following information may be gathered :—

(*i*) In the material collected from the seedlings 7 days after germination, the high proportion with feeding marks upon one cotyledon only indicated that the fly used one cotyledon of a seedling for purposes of feeding and the other for that of oviposition. One egg only had been inserted into the cotyledon of each seedling visited by the fly. Of the larvae collected, two were in the 1st instar, and 4 in the 2nd.

The comparatively large number of cotyledons containing vacant portions of mines indicated that the larvae spent only a short period of time feeding in the cotyledon in which the egg had been inserted.

(*ii*) In the material collected from seedlings 24 days after germination, the absence of larvae from the portions of mines in the cotyledons proved that all the eggs from which they hatched had been deposited in these and not in the rough leaves. All the larvae collected from the latter were in the final (2nd or 3rd) instar. The large proportion of completed mines from which the full-fed larvae had escaped in order to pupate in the soil showed that the whole larval life occupied a comparatively short period of time.

In Table 2, the conclusions drawn above are verified from a smaller number of seedlings ; the absence of eggs again gave evidence of the short period of incubation, and the presence only of well advanced larvae in the rough leaves showed that the fly had always deposited its eggs in cotyledons.

It will be noted that in one seedling two larvae were present in the same plant. Very occasionally, therefore, a single egg was inserted into each cotyledon, possibly by two different flies, and in this event the one larva mined in the cotyledon and rough leaf upon one side of the seedling, and the other upon that opposite, so that the two mines remained separate.

The effect upon the seedling produced by the removal of the greater portion of the tissue within the cotyledons and rough leaves has been referred to under section VI (*a*), page 44.

At the end of January, 1944 the number of newly infested seedlings rapidly diminished, indicating that the adult flies which were responsible for this infestation had ceased to emerge from

Table 2.

Seedlings : 21st day after germination	Examined 8/1/1944	
Total number	207	
Number infested	29	
% infested	14	
Number	*Cotyledons*	*Rough leaves*
With feeding marks	20	—
With a mine or portion of one		
containing a larva	15	6a
vacant	39	19
% containing a larva	27.7	24.0
Number of larvae present	15	7a
,, ,, completed mines vacant	0	8

aTwo larvae in one plant

pupae located in the soil beneath the staging. The flight of these therefore had a duration of some 3 to 4 weeks, and the pupae of the ensuing generation, situated in the soil mainly of the seed boxes, did not begin to emerge until the end of February, giving a pupal period of from 6 to 8 weeks.

This latter period, however, must remain uncertain, for it is possible that the plants, after potting up, had reached a stage of growth at which the flies no longer chose to deposit eggs in the ageing cotyledons, and at which the rough leaves were still unsuitable to them for purposes of oviposition.

(c) Infestation upon Pot-plants

Not until the third week in February 1944 were feeding marks observed upon the foliage. The plants were now ready for planting out in the ground. and the number upon the leaflets of which these marks occurred was very small. It became evident that many pupae of the previous generation had been removed from the houses in the soil of the seed-boxes, but that some larvae had fallen from seedlings, situated along their sides, to the ground beneath the staging and pupated there.

On 29th February, 25 leaflets either with numerous and conspicuous feeding marks upon them, or containing larval mines were collected at random : of these 4 with feeding marks contained no eggs, 8 contained vacant portions of mines, and 13 mines or portions of them were each inhabited by a single larva.

Upon the same date, 29 whole leaves with a complement of 132 leaflets at least one of which on each leaf had been mined by a larva, were collected and examined with the results set out in Table 3.

Table 3

Pot-plants 10 weeks old from date of sowing

Examined 29/11/1944. 132 Leaflets upon 29 whole leaves.	
Number of leaflets	
Without marks or mines	70
With feeding marks	16
With a mine or portion of one	
containing a larva	12
vacant	34
% mined leaflets containing a larva	26
Total Number of larvae collected	21
Number of larvae in leaf-stalks	9
Number of completed mines vacant	6

No eggs were found in any of the leaflets, and it was concluded that the period of incubation was extremely short. Further, it would appear that the flight of adults had only lasted over a period of about one week, so that all had deposited their eggs, which had in the meantime hatched, before the leaves had been collected. But it is possible that the flies had avoided inserting their eggs into leaflets upon whole leaves, which had already been used for purposes of oviposition.

Feeding marks had been made mostly upon the upper surface of the leaflets, but the eggs had been inserted through the lower surface : the feeding-marks were therefore much more conspicuous than those made previously upon the cotyledons. In nearly every case the egg had been inserted near the tip either of an end-leaflet or one of the two leaflets immediately proximal to it upon a whole leaf. The more advanced or completed mines were seldom convoluted, and tended to run more or less alongside of the main-vain into the leaflet stalk. The larva then passed through the tissue of of the leaf-stalk, just beneath the cambium tissue, into a second and often from this into a third leaflet, so that the mine of a single larva extended into three leaflets. From the comparatively large number of completed mines, from which the larva had, as before, escaped in order to pupate in the soil, the duration of the larval life was again computed as being in the region of one week.

After the first week in March, when the plants had been set out in the ground, no further infestation was recorded. In the previous year (1943) on 7th March, leaflets containing larval mines had been confined to a negligable number of plants, which had been planted out in the houses upon the nursery several weeks previously. From half the small number of mined leaflets collected, the larvae had escaped in order to pupate in the ground, and in the remainder all were nearly full-grown. The leaves upon which mined leaflets occurred were situated low down upon the plants.

(d) Bearing of the foregoing investigation upon Control Measures

The measures advocated for the control of Tomato Leaf-miners have comprised, (*i*) the application to seedlings of "atomised" nicotine solution or of nicotine powder, (*ii*) the removal of cotyledons from seedlings, (*iii*) the removal of leaflets containing mines from older plants, and (*iv*) the spraying of older plants with nicotine solution with a view to preventing the flies from inserting their eggs in the leaflets.

It is only necessary to comment upon the first three measures which were put forward, and upon the results computed from their application before the habits and life-history, of *L strigata* had been investigated.

(*i*) The application of nicotine sprays and powders can only kill such larvae as happen at the moment to be leaving their mines in order to pupate in the soil. Pupae upon the leaves are not killed by this treatment. The frequent application of "atomised" nicotine solution when the plants are in the seed-boxes and pots would doubtless lead to the destruction of a considerable number of adult flies during the period over which they are laying their eggs. Such treatment would be likely further to reduce the infestation caused by the second generation of flies in February and March.

There can be little doubt however that part of the decrease in infestation which has been claimed from these methods, has been due to absence of adult flies after termination of the first flight and during the odd six weeks whilst their progeny were in the pupal stage, concealed in the soil, and also to the removal of large numbers of these pupae from the propagating houses in the soil contained in the seed-boxes at the time of potting up the seedlings.

(*ii*) In order to test the effect of removing the cotyledons from seedlings, seed-boxes containing numbers of infested plants were set aside in the propagating house and all seedlings which contained larval mines or portions of them in cotyledons and rough leaves were removed on 8th January, 1944 and submitted to microscopic examination.

The remainder of the seedlings designated " A " in Table 4 were left untouched : from those designated " B " the cotyledons were removed. After a period of one week, all the seedlings in which new larval mines had appeared were removed and examined.

Table 4

Examined 8/1/44 and 15/1/44

Days after germination	21		28	
Seedlings	A	B	A	B
Total number	108	207	99	190*a*
Number with a mine in				
Cotyledons only	3	15*b*	6	—
Cotyledons and rough leaves ...	9	14	7	—
Rough leaves only	0	0	0	3
Total number infested	12*c*	29	13	3
% infested	11.1*c*	14.0	13.1	1.6
Number with mines in rough leaves				
containing a larva	4	6*d*	2	1
vacant	5	8	5	2

a 2 plants damped off : *b* 1 plant collapsed : *c* apparent
d 2 mines in one plant.

A Cotyledons removed B Cotyledons not removed

The number of seedlings recorded as infested in the first column under " A " is only apparent, because of the difficulty of detecting the presence of eggs and very young larvae in situ.

The small number of seedlings attacked amongst those from which the cotyledons were removed is most significant, and shows that the insect is averse to inserting eggs into the rough leaves. That flies had visited these seedlings was evident from an increased number of punctures upon the foliage. In a cluster of these, upon the upper surface of one leaf, five eggs had been deposited, an abnormal procedure in the case of this insect. The fate of the larvae after hatching from a number of eggs thus laid in a single leaf has not been determined, but it is unlikely that any of them would survive for long.

Although the removal of cotyledons at the earlier stages of the plant's growth may truly be said to render the seedlings less liable to attack, the practice is by no means to be recommended.

The destruction by the larva of a greater portion of the collenchyma within the cotyledons deprives the seedling of necessary assimilative tissue, but this applies only to a limited number of plants even in cases of severe infestation. By removing the cotyledons from the seedlings in houses in which the miner makes its appearance, much the same type of injury is caused to all the plants.

If the practice is resorted to with a view to destroying eggs or larvae in the cotyledons, the short period of incubation and the comparatively short duration of the larva's sojourn in them prior to its ascension to the rough leaves are factors which preclude the likelihood of more than a small proportion of them being removed.

It is principally for this reason that the numbers and percentages of mines or portions of them in which the larvae were actually present is given in the fore-going Tables.

(*iii*) The removal of leaflets containing mines from older plants appears to be of little economic value. The details given in Table 3 show that, had such leaflets been removed from the plants, certainly 46 and perhaps as many as 62 would have been totally lost to the plants for the destruction of 12 larvae, and 9 larvae would have been left in the leaf-stalks to complete their development. Further it has been calculated that not more than 5 per cent. of the volume of tissue in each mined leaflet is likely to be devoured by the larva, so that the assimilative functions are hardly interfered with.

During the summer months the larvae are subject to parasitism by Braconids. The parasites themselves pupate within the mines or in the pupa of their host, and the picking off of mined leaves therefore leads to the destruction of a large number of these valuable natural enemies.

Suggested Control Measures

The measure which is most likely to reduce infestations by *L. strigata* would appear to consist in steaming the soil of propagating houses before introduction of the staging, and the growing of plants with a harder type of foliage upon nurseries in the houses of which the miner has been noticed during the previous season.

References

Cohen, M. 1938. Journ. Minist. Agric. 45 No. 5 pp 460-462 Aug.

Speyer, E. R. 1926. Exp. & Res. Sta. Cheshunt 12th Ann. Rep. p 58.

1936. Ibid. 22nd Ann. Rep. p 70.

1938. Ibid. 24th Ann. Rep. pp 67-72.

7. A Fruit-fly in relation to Grape-Vine

In November 1943 ripe bunches of Colmar grapes were received from a nursery in Sussex. A number of the grapes were scored with depressed areas and furrows from which juice was exuding ; others had partially rotted and to the drier portions the yellow or brown pupae of a Dipterous insect were attached. From the pupae, flies, determined by Dr. J. Smart as *Drosophilla melanogaster Mg.*, emerged after a period of one week.

In some, but not in all, of the furrows, the curious " alate " eggs of the insect floated upon the juice, and larvae in all stages of development had sunk beneath the surface of the fermenting liquid.

The insect had not been responsible for the injury and had merely been attracted to the fermenting juice. Physiological disorder due to age of the stock had brought about the condition of the bunches.

8. Scarabaeid Beetles as Pests of Mushrooms

Two species of the genus Aphodius, *A. fimentarius* L. and *A. subterraneus* L. have recently been causing injury to mushrooms in widely separated localities. They devour large portions of the caps during June and July.

The beetles are about one-third inch in length ; the head and thorax is shiny black and the elytra either red or black. They are common inhabitants of horse manure.

Treatment of the soil surface with Derris, Pyrethrum, or Nicotine powder had no effect upon the insects, but many years ago large numbers were trapped in the tomato houses at the Cheshunt Station with mangolds, cut in half and placed cuts-side downwards upon the soil surface.

9. Root-knot Eelworm (*Heterodera marioni* Cornu)

Two small plots in an experimental glasshouse were again utilised to determine if application of Thymol to the soil would prevent tomato roots from attack by this Nematode. To the soil of one infected plot, acting as a control, water was applied at the rate of 4½gallons per square yard : to that of the other a similar quantity of water containing Sodium thymolate at the rate of one fluid ounce per gallon (giving a Thymol concentration of 1:800) was applied on 18th April. Four days later, 6 tomato plants with an average height of 6 inches were planted in each plot. On 22nd August the plants in the treated plot averaged 9 feet in height, and those in the control 8 feet. The roots were examined on 12th September and found to be infested with nodules-in the treated plot, 1 plant very severely, 4 plants severely, 1 plant moderately : in the control, 2 plants severely, 1 plant moderately, 3 plants lightly.

It is concluded that applications of Thymol are not likely to be effective in controlling the pest.

10. A Preliminary Report on the Control of Tomato-moth Caterpillars with Preparations containing D.D.T.

W. H. READ

Most nurserymen have become acquainted through the medium of the technical and lay press, with the synthetic insecticide known in this country as D.D.T. The name given to this substance is derived from its chemical name dichloro-diphenyl trichloroethane. Although this substance was first prepared as long ago as 1874 it is comparatively recently that its insecticidal potency was discovered by a Swiss company, J. R. Geigy, A.-G. During the last few years many workers in this and other countries have investigated its value for the control of a wide range of insect pests. Its use for insecticidal purposes is covered by a number of patents dealing with compounds of this type, taken out by Geigy. D.D.T. is being made in large quantities in this country but at present practically the whole production is required by Service departments.

Many experiments have been made with sprays and dusts containing D.D.T. during the past year. Some of these were of an exploratory character but extensive trials have been made with tomato-moth caterpillars (*Polia oleracea*). In the past spraying with preparations and mixtures containing derris has been the only practical method of dealing with this pest when the presence of fruit prohibits the use of lead arsenate. D.D.T. sprays possess an advantage over derris sprays since the toxic principle persists on the foliage for a considerable time as will be seen from the results of experiments to be described later. Although there appears ample evidence that D.D.T. is not toxic to man in amounts which will be employed for the control of tomato-moth caterpillars it is hoped that an official pronouncement on all aspects of this question will be issued shortly so that any doubts may be dispelled.

Dusts containing D.D.T.

In the majority of experiments with dusts a D.D.T. content of 5% has been employed in order to keep the dust deposit on fruit and foliage low. The merits of dusting as compared with spraying have not been fully examined.

The dust used for most trials was prepared by dissolving the calculated amount of commercial D.D.T. in acetone, thoroughly mixing the solution with kaolin powder, evaporating off the solvent and sieving the product through a 100 mesh sieve.

In one experiment eighty-eight caterpillars of all stages from newly-hatched to fully grown were distributed on forty tomato plants, about 4 feet high, growing in a small glasshouse. The plants were then dusted with the 5% D.D.T./kaolin dust using 2 ozs. of dust to treat the forty plants. Within a few hours all the caterpillars had fallen from the plants. The eight smallest caterpillars were motionless but some of the larger caterpillars were capable of slight movement up to 48 hours after being dusted. No caterpillars returned to the plants, and several of the large caterpillars which were removed three hours after they were dusted and placed on undusted tomato leaves, died without attempting to feed.

Fully grown caterpillars placed on the dusted plants 12 days after the dusting were killed, and a number of caterpillars which had emerged from their eggs less than 24 hours did not survive when placed on leaves which had been dusted twenty days previously. In this connection it is necessary to point out that the plants were not damped overhead. No determinations of the maximum time during which plants, dusted at various rates, retain sufficient D.D.T. under commercial conditions to destroy caterpillars, has been made so far.

The effect of dusts containing D.D.T. on the eggs of tomato-moths is of interest but since dusted leaves may remain sufficiently toxic to destroy larvae emerging from eggs which may have been present when the plants were dusted, ovicidal activity is not so important. Observations were made on a number of egg masses. The eggs were laid on pieces of muslin and these were pinned to the leaves of tomato plants and dusted with a 5% D.D.T. dust. The eggs changed colour as if normal development was taking place but many failed to hatch. They were examined by the Entomologist who found that many larvae had been killed whilst in the process of hatching. An account of Mr. Speyer's examination of both dusted and sprayed eggs will be found in the Entomological report.

None of the dusts used in the experiments caused injury to the plants and fruit which was dusted with an excessive amount of dust was free from any abnormal taste when the dust was brushed off.

Sprays containing D.D.T.

Experiments with sprays have been made with emulsified solutions of D.D.T. in organic solvents and petroleum emulsion sprays to which D.D.T. solutions have been added. The results obtained must be regarded as of a preliminary character since much work remains to be done on the influence of various factors on the efficiency of emulsions containing D.D.T.

In small scale glasshouse trials with emulsions of D.D.T. prepared in the laboratory, it was found that a concentration of .02% D.D.T. in the spray fluid was sufficient to kill all stages of

tomato-moth caterpillars. Newly hatched caterpillars were killed by sprays containing .007% D.D.T. Experiments which were in progress to determine the length of time foliage sprayed with different concentrations of D.D.T. retained its toxicity to tomato-moth caterpillars could not be completed owing to the destruction of the plants by enemy action. The results of another experiment showed that plants sprayed with a wash containing .02% D.D.T. retained sufficient toxicity to kill tomato moth caterpillars about half-an-inch long (4th instar) for at least 6 days.

The ovicidal properties of sprays containing D.D.T are of interest though relatively unimportant as far as the control of tomato moth caterpillars is concerned in view of the retention of toxicity by sprayed leaves. A number of egg masses were sprayed with a D.D.T. emulsion diluted to contain .013% D.D.T. Their development was studied by the Entomologist and his account of his observations will be found elsewhere.

D.D.T.—petroleum oil mixtures

Red spider mites are not susceptible to sprays or dusts containing D.D.T. and in consequence it will be necessary in many cases to spray with petroleum emulsions for the control of this pest when tomato moth caterpillars are also present. Experiments were made, therefore, with petroleum emulsion sprays to which D.D.T. was added. A solution of 20 ozs. D.D.T. and 16 ozs. triethanolamine oleate in ½ gallon acetone was found convenient for this purpose. Complete control of caterpillars of all stages was obtained in tests in a small glasshouse and in large scale trials on commerical nurseries by a single application of 1 in 100 petroleum emulsion* to which the D.D.T. solution was added to give .0215% D.D.T. in the spray fluid.

On one nursery where the trial extended over more than an acre, there was a very severe infestation of caterpillars in September but no live caterpillars could be found after one application of the petroleum emulsion-D.D.T. mixture containing 0.02% D.D.T. Moths flying about the glasshouses were killed. There was no sign of injury to the plants or fruit.

Other tests showed that where 0.01% D.D.T. was present in a petroleum-D.D.T. mixture containing 0.75% petroleum, some fully grown larvae which did not feed after being sprayed were able to pupate after being sprayed. Where almost fully grown larvae fed on the leaves 0.01% D.D.T. in the spray fluid proved fatal. Where the spray fluid contained .02% D.D.T. fully grown larvae were killed by contact action only.

* The petroleum emulsions used in these trials were standard proprietary products widely employed for the control of red spider mites on tomatoes.

Fruit sprayed with mixtures containing .08% D.D.T. appeared free from any unnatural flavour.

More recently petroleum emulsions have been prepared in which D.D.T. is incorporated in the stock emulsion. This procedure may have advantages over the addition of solutions or emulsions of D.D.T. to diluted oil emulsions where control of red spider mites must also be obtained.

In addition to trials with preparations made in the laboratory, tests have been made with proprietary products containing D.D.T.

A number of factors require investigation before definite recommendations can be made regarding the use of D.D.T. for the control of tomato moth caterpillars, including the effect of D.D.T. upon derris-petroleum mixtures used to control red spider mites early in the year.

Discussion

Tomato moth caterpillars are very susceptible to D.D.T. applied in dusts or sprays and this substance may replace derris and lead arsenate for the control of this pest. The relative merits of spraying and dusting under commercial conditions have not been investigated but dusts may prove more advantageous than sprays whilst the plants are small owing to the ease and rapidity with which they can be applied.

Sprayed or dusted leaves retain their toxicity over a considerable period but owing to the rapid growth of tomatoes retention of toxicity over long periods is not of major importance. A concentration of 0.02% D.D.T. in sprays appears sufficient to destroy all caterpillars of tomato moths.

D.D.T. can be used in conjunction with petroleum emulsions yielding a spray which will control both red spider mites and tomato moth caterpillars. For this purpose the D.D.T. can be added to the diluted oil emulsion or incorporated in the stock petroleum emulsion.

Appreciation is expressed to Messrs. Stafford Allen, Ltd., for supplying a quantity of D.D.T. (Geigy); to Mr. Smitts for his aid in conducting large scale trials and to Dr. H. Martin for supplying a sample of D.D.T. dust.

5. CHEMICAL PROBLEMS

O. OWEN

(1) General

The general nature of the advisory work has been on lines similar to those already recorded during the past few years. Of the matters of interest already commented on, difficulties in the propagation of tomato plants have increased considerably during the year under review. The three main causes of failure have been :

(1) Inefficient sterilization
(2) Unsuitability of the mixture as a rooting medium
(3) Lack of soluble phosphates

While the soil available may vary from time to time, it appears that in general, a bulk mixture of 1 part of stable manure with 5 parts of maiden loam gives consistently satisfactory results as a rooting medium. After this has been sterilized the addition of 12-16 ozs. 16-18 per cent. superphosphate per hundredweight will be adequate under most conditions.

Another common occurrence was a request for the mixing of " straight " fertilizers for use for different purposes. There are still a number of useful materials available which do not require permits and generally speaking, they can all be used in conjunction with the rationed fertilisers.

There have been an increasing number of queries concerning possible mineral deficiencies on tomatoes. Of these the commonest is magnesium deficiency and work on this is described in a later section of this report. A few cases of manganese deficiency have been dealt with and a few where iron has been the deficient element. There appears to be a growing tendency to conclude that any unusual condition in a plant must be due to a deficiency and often steps are taken to correct the condition, before the diagnosis has been confirmed. It is suggested that, before any steps are taken in this direction, growers should be satisfied that the signs or symptoms are indeed due to a specific deficiency. Ample advisory facilities are now available to enable all growers to obtain expert opinion on suspected cases.

(2) The use of Muriate in place of Sulphate of Potash

Again the effects of these treatments on the chloride concentration have been followed. The results for analyses made at approximately monthly intervals are given in Table 1.

As in previous years the results show wide fluctuations but, in the main, they follow the manurial treatment and cultural operations. The base potash dressings (10 cwt. per acre respectively) were applied on February 18th. These are reflected in the increases in values for March 6th over those for February 3rd.

Table 1 Showing Total Chlorides (%NaCl) for Soil dried at 100°C.

	Jan. 3*rd*	*Feb* 3*rd*	*Mar.* 6*th*	*Mar.* 31*st*	*May* 5*th*	*June* 2*nd*	*July* 3*rd*	*Aug.* 2*nd*	*Sept.* 4*th*	*Oct.* 2*nd*	*Nov.* 7*th*	*Dec.* 11*th*
71s. ...	.00718	.00699	.0254	.0215	.0199	.00999	.00679	.00614	.00708	.00840	.00782	.00701
72m. ...	.00934	.00679	.1841	.1112	.1595	.0397	.0104	.0123	.0158	.0102	.00863	.00636
73s. ...	.0139	.00860	.0176	.0181	.0174	.00455	.00623	.00654	.00578	.00637	.00914	.00595
74m. ...	.0123	.00634	.266	.1201	.1888	.0242	.0247	.00931	.00520	.0206	.00818	.00656
81m. ...	.0128	.0115	.1493	.1821	.2074	.0251	.0185	.00957	.00700	.0105	.0127	.0126
82s. ...	.00990	.00764	.0177	.0474	.0205	.00678	.0082	.00637	.00484	.00608	.00821	.00615
83m. ...	.0111	.0133	.1632	.1934	.1410	.0155	.0115	.00691	.00558	.00964	.0145	.00369
84s. ...	.00823	.00781	.0144	.0164	.0292	.00779	.00818	.00573	.00462	.00956	.00409	.00512
91m. ...	.0106	.0113	.2355	.1499	*.0245	.0263	.00718	.00759	.00640	.00997	.00576	.00820
92m. ...	.00710	.0103	.1903	.1600	*.0204	.0124	.00678	.00512	.00610	.0107	.00657	.00782
93s. ...	.0118	.00963	.0144	.0154	*.00100	.00740	.00719	.00738	.00750	.00741	.00492	.00532
94s. ...	.00857	.0105	.0651	.0182	*.00615	.00819	.00738	.00695	.00651	.00818	.00492	.00409

*May 16th

A first top dressing at 5 cwts. per acre given on April 28th is reflected in the general increase in values where muriate was applied in houses 7 and 8. From June onwards no muriate or sulphate of potash was applied and with a few exceptions, there is a reduction in values to the end of the season. At the end of July much of the glass in these houses was broken and normal cultural operations were suspended until September when the soil was steam sterilized. The flooding which followed effected a reduction in values and in December values for sulphate plots varied from 0.004% to 0.007% and for muriate from 0.003 to 0.01.

It will be noted that the highest value recorded is 0.27 (7.4m) on March 6th. So it is evident that the tomato will stand quite high concentrations of chloride provided it is not maintained. Another conclusion which is confirmed is that the excessive chloride can be washed out of the soil by water which is reasonably free from chlorides. In connection with this, however, it must be borne in mind that the removal of chlorides by leaching is inevitably accompanied by losses of potash.

In Table 2, are shown the chloride content of three different batches of samples of leaves taken from the different plots on the dates shown.

Table 2

Plot	*Treatment*	*Variety*	*Total chloride in dry matter of foliage* (%Cl)		
			June 17th	*July 15th*	*August 26th*
71	Sulphate	Potentate	1.37	2.25	2.43
72	Muriate	,,	4.42	5.15	4.49
73	Sulphate	,,	2.22	1.22	2.55
74	Muriate	,,	2.69	2.88	1.73
81	Muriate	,,	4.87	5.34	5.91
82	Sulphate	,,	3.91	2.15	3.96
83	Muriate	,,	5.12	4.12	5.53
84	Sulphate	,,	.575	2.11	4.04
91	Muriate	E.S.1.	3.68	4.58	6.37
92	Muriate	,,	2.62	4.96	5.99
93	Sulphate	,,	2.46	1.94	2.13
94	Sulphate	,,	3.51	2.74	3.96

As was the case in 1943, values are not consistently different for the two varieties, despite the difference in the effects of the muriate and sulphate respectively, on the foliage.

What is somewhat unexpected is that some of the values are so high even where sulphate has been used.

(3) The Effect of Sulphur and Sulphuric acid on the reaction of a tomato soil.

These experiments have been continued in House 5, and the results confirm last year's conclusion that sulphur at 2 ozs. per square yard or the equivalent amount of sulphuric acid and sulphur at 4 ozs. per square yard has little permanent effect on the reaction. Typical figures are shown in Table 3.

Table 3

Treatment	*pH before treatment*	*pH before treatment*	*pH at end of season (Dec. 11th)*
2 ozs. Sulphur/sq. yd. ...	7.90	7.57	7.75
4 ozs. Sulphur/sq. yd. ...	7.56	7.27	7.82
Sulphuric acid ...	7.95	7.18	7.88
Control	8.01	7.88	7.75

In considering these values it must be remembered that at the end of the season all these plots contained over 2 per cent. of calcium carbonate. As was the case last year, the immediate reduction in the reaction value after the addition of sulphuric acid does not persist and it is likely that, as already suggested, lime moves upwards in the soil.

Clearly the comparatively small dressings of sulphur cannot have any great effect on the carbonate content of the soil or on the reaction under present conditions. Accordingly, larger dressings of sulphur will be used in 1945. In this connection we have records of a reduction in crop when dressings of 8 ozs. and 1 lb. of sulphur per square yard were applied.

(4) Trace elements in Tomato Nutrition

Very little progress was made in this work. When the results of experiments were to be expected practically all the glass of the experimental chamber was broken and when repairs were completed it was too late in the season to start a new series of experiments.

(5) Magnesium deficiency in Tomatoes

For many years magnesium deficiency symptoms in tomatoes have been known and recognised, and have been associated with two different sets of conditions. The first which is quite common, occurs during early and mid-season and is probably due to physiological strain. It is dealt with under " A " below. The second is more permanent in its effect and may depress yield and is due to undesirable physical conditions in the sub-soil. This is discussed under " B."

More recently a new type of deficiency condition has occurred in many parts of the country. It is unlike either of the other two in that it is not confined to one part of the season nor is it due to physically unsuitable sub-soils. It is discussed under " C."

A.—Deficiency due to physiological strain

This condition is quite common and is well known among experienced growers. It occurs in apparently well grown plants when they are 4 to 5 feet high and carrying a heavy crop. The fruit is of all sizes from the full marketable size to the small fruit which has just set.

At this stage from the grower's point of view, the plant is expected to perform a variety of functions :—

(1) The larger fruits must mature—that is, colour to a marketable condition.

(2) The smaller fruits are required to swell and eventually mature.

(3) Bloom must set.

(4) Growth at the tip must be maintained to provide the " top " crop which is to follow.

It is clear that there must be a heavy strain on the plant under these conditions and the result is often twofold. The more obvious effect is that the leaflets develop the signs of magnesium deficiency. The leaflet tends to curl downwards and yellow areas develop interveinally. These areas extend and in acute cases the whole leaf may become yellow. At the same time the veins retain a dark green colour and quite often, but not always, the margins remain green. This condition is well known and causes little concern because it appears to have no effect on yield and when picking of fruit has been in progress for some little time, the upper part of the plant remains green and continues so to the end of the season.

The rather more subtle effect is sometimes seen in the tip which becomes thin and assumes a greyish-green colour. If this persists as sometimes happens there is a risk that the trusses then being formed will fail to set.

Both these effects can be reduced very effectively if not obviated if a dressing rich in nitrogen is applied to the soil at the right time. A very useful mixture which met with wide approval when the ingredients were available consisted of 1 part nitrate of potash, 1 part sulphate of ammonia, 3 parts superphosphate, and 5 parts dried blood. This was applied at the rate of 2 ozs. per square yard. Experience suggests that the dried blood is the effective ingredient in this mixture. Time of application is important and an experienced plant reader can usually decide the best time and so

forestall the onset of deficiency symptoms. Where experience of this sort is not available we make a general empirical recommendation that this or a similar mixture, be applied when the fifth truss is in bloom for varieties of the Ailsa Craig and E.S.1. type and when the fourth truss is in bloom for the Potentate type. This, however, must not be regarded as a hard and fast rule, and it often happens that Potentate or Vetomold growing in cucumber houses benefit from a dressing six weeks after planting.

It would thus appear that an important factor in this deficiency is the available nitrogen status of the soil and it is interesting to note that it has already been shown that in glasshouse soil, nitrate nitrogen is lost at the time when symptoms can be expected to develop.

This is in accordance with the claim that high soil potash tends to induce magnesium deficiency. From our point of view soil potash must be considered in relation to nitrogen and what may be regarded as high potash content at one nitrogen level is not high when the nitrogen is increased appreciably.

B.—Deficiency due to unsuitable physical conditions in the sub-soil

This effect is generally associated with a sub-soil whose drainage is inefficient. It is of long standing and is characterised by what may be termed a random incidence ; that is to say, batches of plants in a house or a block of houses may show the effects while surrounding plants retain their normal colour and appearance. In this case it usually happens that there is a depressing effect on yield and often the plants develop premature senescence and die early.

The effect can be reproduced fairly well by growing plants under artificially produced waterlogged conditions.

It can be corrected by improving the drainage in the sub-soil.

Here again it appears probable that nitrogen may be a contributory factor because under these conditions nitrification must be practically non-existent while conditions are favourable to nitrate disappearance.

C.—Deficiency in open soils

As already stated this is a comparatively recent development. It has occurred so often in sandy soils that the view has been put forward that heavy potash dressings so usual in tomato culture have denuded the soil of the exchangeable magnesia. While this may be so in some cases it does not appear to be true generally. In many cases brought to our notice, the soil has not always been sandy although permitting satisfactory drainage and aeration.

Again, at the Station we have in one block. plots which have received sulphate of potash at the rate of 15 cwts. or more per acre per annum, and water at the rate of some 800,000 gallons per acre per annum for twenty years and we have yet to see magnesium deficiency. It must be added, however, that we have applied the dried blood mixture when necessary.

In cases where this deficiency occurs it would appear that a general feature is deep rooting into good soil of a light nature and the symptoms only develop after the roots have got into the subsoil.

There are at least two reasonable explanations. The one is that in these sub-soils there may be a factor or condition which prevents the uptake of magnesium. The other is that the sub-soils are too poor in nitrogen.

If either or both of these explanations is the right one it seems difficult to correct the conditions on a commercial scale. Further, if magnesium which is present in the soil cannot be utilised there would be some expectation that some, if not all, added magnesium would be equally useless. In this connection, too, there is the risk of replacing other soil bases by magnesium which might well have undesirable effects on tilth.

Taking these and other matters into consideration it seemed that the most promising method of applying magnesium would be via the foliage in the form of a spray.

Preliminary experiments under commercial conditions gave indications that this method would be effective and work was then planned to determine what strength was safe and effective.

The range of concentration of Epsom Salts was 1 to 5 per cent. by weight with and without a wetter. As far as possible different types of plants, *i.e.* " hard," " soft," and normal plants of various ages from 18 inches high upwards were sprayed with these solutions, under different weather conditions.

Briefly the results were as follows :

Under all conditions a 5 per cent. solution caused serious damage to foliage and flowers. Solutions containing 3 and 4 per cent. generally caused damage to flowers and flower stems, and often to foliage. A solution containing $2\frac{1}{2}$ per cent. plus a wetter occasionally, caused some damage to the flower trusses, and very rarely to the foliage. Curiously enough, the damage with this concentration always occurred when the spraying was carried out on a dull day which was followed by bright sunshine.

A 2 per cent. solution plus wetter caused slight damage to flowers and very slight damage to foliage on one occasion only. The plants were very free growing and the spraying was carried

out on a dull afternoon. The subsequent three days were sunny and the slight damage was observed on the second day. It appears therefore, that a 2 or 2½ per cent. solution can be used with safety, and both these concentrations have been tried on mature plants under commercial conditions with satisfactory results.

It is important to note that the addition of a wetter is essential as, in many experiments where it was omitted, damage was often severe.

Experiments will be carried out on commercial nurseries in 1945, using a 2 per cent. solution. The solution will be made by dissolving 20 lbs. Epsom Salts in 100 gallons of water and a proprietary wetter added.

In our experiments sulphonated lorol at the rate of 8 ozs. per 100 gallons, or Agral at the rate of 6 fluid ounces per 100 gallons have proved effective.

Growers whose plants suffer from magnesium deficiency are recommended to try this solution. In acute cases it is advisable to spray 8 to 10 weeks after planting and to repeat the process every 14 days. How long this will be necessary is not know at present but it will probably not be advisable to stop until the 6th truss is ripe for picking.

(6) Trace Elements in Lettuce Nutrition

Preliminary experiments were planned to determine the effect of deficiences in the winter lettuce Cheshunt Early Giant. A new supply of sand was used for these experiments and this proved quite unsuitable. On the whole, results were far from satisfactory. In all cases young plants were well established in a complete nutrient solution before a deficient solution was applied. The following indications were obtained :

Boron

The main effect was restricted growth and a comparatively small root system. There was considerable distortion of the leaves at the heart and some marginal scorch.

Iron

No appreciable effect on size but the foliage was definitely less green and there was slight marginal scorch.

Magnesium

There was pronounced restriction in growth and the root system was small. Many leaves were puckered and mottled and there was a fair amount of marginal scorch.

Manganese

A mild chlorosis was general but there was little effect on size or root development.

(7) The effect of 2.4-dichlorphenacetic acid and beta-naphthoxyacetic acid on fruit setting in tomatoes.

Both these compounds have been shown in America to induce setting of tomato flowers to produce parthenocarpic fruit.

During the normal growing season and under ordinary commercial conditions under glass, the standard varieties of tomato can be made to set quite satisfactory with competent cultural treatment. During the winter months, however, setting is at best uncertain and it appeared worth while to test these compounds with a view to their use for very late or very early crops.

It was soon established, in accordance with the results of other workers, that parthenocarpic fruits were produced when dilute solutions of either of these compounds are sprayed through an atomiser on to the flowers, just when they are opening. Ripening of the fruit is hastened and in some experiments this has occurred to the extent of 12 days. Another feature of this treatment is that the majority of the fruit on a truss often ripen at the same time.

Unfortunately both compounds are liable to cause epinasty and injury to flowers and flower stems. Tomato plants will tolerate a much higher concentration of beta-naphthoxyacetic acid than of the 2.4 dichlorphenacetic acid. It is clear that the problem of application of these and similar compounds is a twofold one. Not only it is necessary to determine the concentration which is operative with a minimum of injury but, in addition, the absolute amount left on plant tissue may have a bearing on the risk of injury. In this latter connection it may be mentioned that the choice of suitable wetting agents is important as the extent of the retention and " run off " of hormone may well be as important as its concentration.

The work is being continued and it appears, at the moment, that a good deal more knowledge is required before the use of these compounds can be recommended on a commerical scale.

(8) The Determination of " available " Potash and Phosphoric Acid in Tomato Soils.

O. OWEN and P. O. REES

This report presents the analytical data obtained for one of the experimental plots here during 1943 and 1944.

Potash and phosphoric acid were extracted by three solutions:—

(1) 1 per cent. citric acid.

(2) N/2 acetic acid (1).

(3) Distilled water.

In addition phosphoric acid was also extracted by :—

(4) Acetic acid buffered at pH 4.8 (2).

(5) N/500 sulphuric acid buffered at pH 3.0 (3).

In all the determinations potash was estimated as the perchlorate and the phosphoric acid as the molybdenum blue by a method details of which were kindly supplied by Professor G. W. Robinson.

Table 1 gives the data for 1943 and shows :—

(1) The manurial treatment of the plot.

(2) The potash extracted by the three solvents used.

Table 1 (1943)

		Per cent. K_2O		
Date sample was taken	*Manurial Treatment– applied ½ to 1 day after collecting sample (plot steamed in 1942)*	*Extracted by 1% citric acid*	*Extracted by N/2 acetic acid*	*Extracted by distilled water*
Feb. 1943		0.069	0.135	0.069
April 25th		0.042	0.156	0.028
May 20th	1 oz. per sq. yard of nitrate of soda	0.068	0.279	0.047
June 1st	1 oz. per sq. yard of superphosphate	0.075	0.153	0.057
June 12th		0.097	0.20	0.067
July 7th	2 ozs. per sq. yard of a " tonic " mixture =10.4% N., 4.8% P_2O_5 ; 4.5% K_2O	0.071	0.10	0.033
July 27th	2 ozs. per sq. yard of a mixture=7.2% N. 7.9% P_2O_5 ; 5.9% K_2O	0.098	0.112	0.054
Sept. 15th		0.082	0.208	0.038
Nov. 9th	(Winter flooding Nov. 2nd)	0.013	0.079	0.019

The obvious general conclusion that can be drawn from these data is that the heavy winter flooding in early November has reduced the potash extracted in all these cases. The effect as measured by the three extractants, however, is very different. In the case of citric acid the value is reduced to about a sixth, in the case of acetic acid to about a third, and in the case of water to a half. This suggests that the categories of potash extracted are not the same for all three solvents.

One particular point of interest is that following an application of superphosphate, samples taken June 12th all show increases of potash over their immediate predecessors. Earlier work here showed that under certain conditions phosphate increased the potash content of tomato foliage and the present results indicate that they may actually affect the availability of soil potash.

Beyond these two points there appear to be no general inferences which can be made with safety and it has to be borne in mind that there are two opposing factors operating. These are, the application of fertilisers on the one hand and the uptake by the plants plus losses in drainage on the other. These latter are appreciable and, under our conditions, may amount to 30 per cent. of the total uptake by the crop (4).

For 1944 it was decided to divide the plot into four bays to examine the effect, if any, of different treatments on the potash status.

The results are shown in Table 2 which is arranged on the same lines as Table 1.

It must be pointed out here that on July 21st, 1944, much of the glass in this house was blown out as the result of enemy action. After that date cultural operations were discontinued and until late in the year the soil was exposed to ordinary climatic conditions.

In considering Table 2, Bay 4 being unmanured is easiest to deal with as the complication of the fertilisers effect is absent. Measured by the three extractants, the potash is reduced between 11th March, 1944 and 18th September, 1944 in the first case from .0466 to .0202 ; in the second from .104 to .057 and in the third from .0186 to .0044.

These decreases are to be associated with the concurrent effects of uptake by the plants and losses by leaching.

After 18th September, 1944 what is to be said about Bays 1-3 will apply to Bay 4.

Turning now to a consideration of the data for Bays 1-3, the differences in values for potash between 15th April, 1944 and 27th May, 1944 are, in the main, consistent with soil treatment. Between these two dates the plants had made a fair amount of growth and heavy watering had started. These two factors would account for the fall in potash values shown. When the next lot of samples were taken on 24th June, 1944, however, the effects are nothing like so consistent. Potash soluble in citric acid solution has increased in all three bays, the inference being that the increase in potash measured in this way is the nett effect of manurial treatment versus losses in drainage and uptake by the plants. Potash

DIAGRAM SHEWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1944

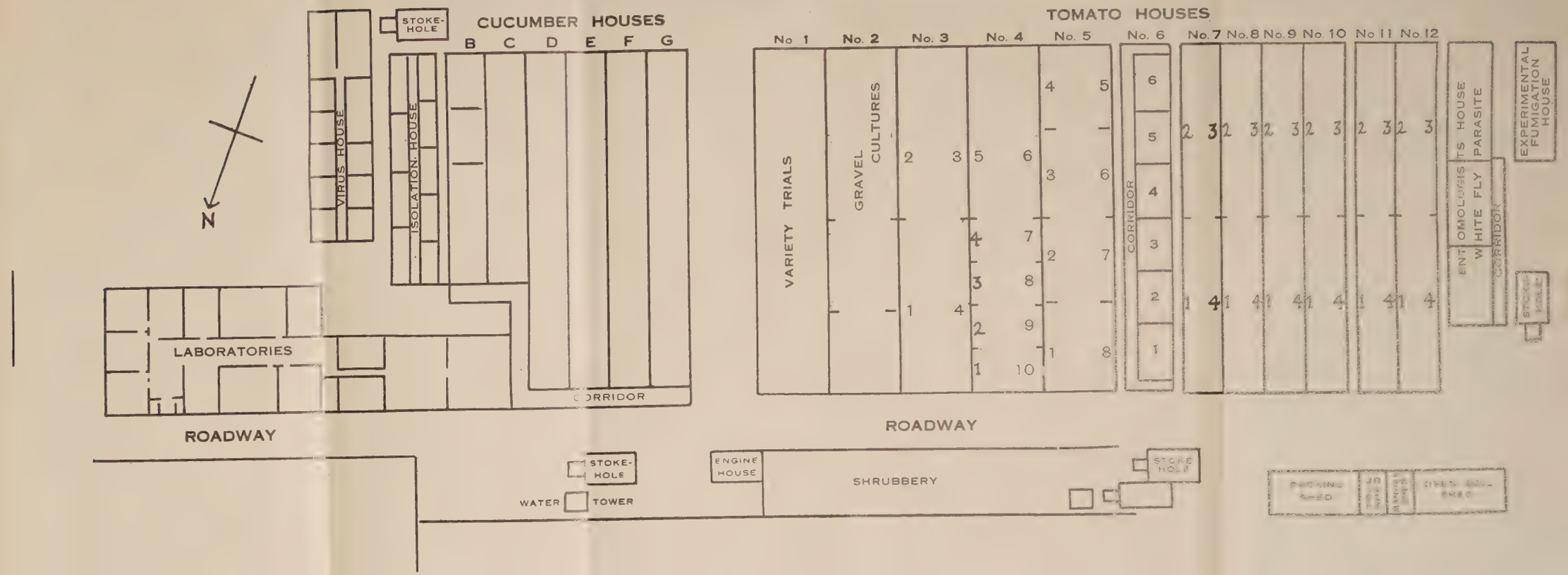

TABLE 3

Date of Sampling	*Ratio*	*Date of Sampling*	*Bay 1 Ratio*	*Bay 2 Ratio*	*Bay 3 Ratio*	*Bay 4 Ratio*
February 1943	1.96	March 11th, 1944	2.23			
April 25th, 1943	3.72	April 15th, 1944	2.63			
May 20th, 1943	4.10	May 27th, 1944	5.89	2.13	2.40	2.61
June 1st, 1943	2.04	June 24th, 1944	2.44	1.84	1.49	2.92
June 12th, 1943	2.06	July 27th, 1944	1.54	2.2	1.34	2.33
July 7th, 1943	1.41	August 16th, 1944	1.82	1.34	2.16	2.82
July 27th, 1943	1.14	September 18th, 1944	2.6	1.61	2.16	2.82
Sept. 15th, 1943	2 54	September 21st, 1944	2.7	2.55	1.84	2.18
Nov. 19th, 1943	6.08	October 23rd, 1944	2.5	2.43	2.86	2.28
		November 18th, 1944	1.76	2.90	2.10	2.22
		December 20th, 1944	2.22	2.16	1.55	4.45

extracted by N/2 acetic acid and distilled water, however, show a less consistent trend and suggest a reduction in potash. This again indicates that citric acid and acetic acid are affecting different categories of potash.

The 27th July, 1944 samples in the three bays all show increases compared with their predecessors. These can be explained by the following facts. On July 21st much glass was blown out, and the consequent reduction in temperature and mechanical damage to the plants reduced transpiration. As a result, no water was applied for eight days prior to the 27th July, 1944 sampling. All these factors operating the same way would tend to reduce any loss of potash. In addition there is some evidence to show that "available" potash does increase when soil disturbance is at a minimum.

Between 27th July, 1944 and 18th September, 1944, most of the soils were exposed to rain and there was some watering prior to steaming, and this accounts for the general reduction in potash values.

The immediate effect of steaming is not consistent. It has already been shown (5) that steaming the soil may increase the citric acid soluble potash by 100 per cent., providing the soil is not watered. In this particular instance between 18th September, 1944 and 18th November, 1944 all the bays were watered at the rate of over 200,000 gallons per acre and the values for potash which follow are of course, the nett result of any increase which the steaming would cause and the losses due to watering. Obviously it is unlikely that either the distribution of the water over the surface or the rate at which it drains through the soil is uniform and this would account for the variations in the differences of the three bays. These considerations will also apply to the values for 20th December, 1944.

For a variety of reasons we have decided that the N/2 acetic acid is the most likely successor to 1 per cent. citric acid. What is necessary now, is that we should endeavour to show some relation between the potash extracted by these two extractants.

Table 3, gives the ratio.

$$\frac{\text{Per cent. potash extracted by N/2 acetic acid.}}{\text{Per cent. potash extracted by 1 per cent. citric acid, for the data we have obtained.}}$$

Averaging the whole of the values for this ratio the result is 2.45. Now if this is valid all we need do is to multiply our citric acid critical values by this factor and we have a scale on which we can use a rather extensive experience of analyses of glasshouse soils. Our colleague Dr. Selman, has kindly examined the values and

TABLE 3

Date of Sampling	*Ratio*	*Date of Sampling*	*Bay 1 Ratio*	*Bay 2 Ratio*	*Bay 3 Ratio*	*Bay 4 Ratio*
February 1943	1.96	March 11th, 1944	2.23			
April 25th, 1943	3.72	April 15th, 1944	2.63			
May 20th, 1943	4.10	May 27th, 1944	5.89	2.13	2.40	2.61
June 1st, 1943	2.04	June 24th, 1944	2.44	1.84	1.49	2.92
June 12th, 1943	2.06	July 27th, 1944	1.54	2.2	1.34	2.33
July 7th, 1943	1.41	August 16th, 1944	1.82	1.34	2.16	2.82
July 27th, 1943	1.14	September 18th, 1944	2.6	1.61	2.16	2.82
Sept. 15th, 1943	2.54	September 21st, 1944	2.7	2.55	1.84	2.18
Nov. 19th, 1943	6.08	October 23rd, 1944	2.5	2.43	2.86	2.28
		November 18th, 1944	1.76	2.90	2.10	2.22
		December 20th, 1944	2.22	2.16	1.55	4.45

he finds that the standard error is of the order of ± 1.3 which is excessive. The high values 4.10, May 20th, 1943, 6.08, November 9th, 1943, 5.89, Bay 1, May 27th, 1944, and 4.45, Bay 4, December 20th, 1944, can be explained away on the assumption that different categories of potash are extracted by N/2 acetic acid and 1 per cent. citric acid. These two categories are differently affected by the watering which preceded the taking of the particular samples mentioned. The reduction in citric acid soluble potash is always greater than that of the acetic acid soluble. It must, however, be pointed out that these effects should operate throughout, *i.e.* high values for the ratio should have been obtained in Bays 2 and 3 on May 27th, 1944, and high values should have resulted in all plots on December 20th, 1944.

Clearly, it is desirable to obtain more values for this ratio and it may well be that if samples are taken after little or no disturbance by way of watering or manuring, that the standard error will be less.

In conclusion, one point of practical interest may be mentioned. Experience indicates that a level of 0.06 per cent. K_2O soluble in 1 per cent. citric acid is necessary for satisfactory tomato growth. On this basis the following deficits obtain in Bays 1, 2, 3, in December, 1944 :—

	Bay 1	*Bay* 2	*Bay* 3
K_2O deficit ...	.0297 per cent.	.0246 per cent.	.0287 per cent.

Converted into ounces per square yard these correspond to :—

Bay 1	...	3.76 ounces sulphate of potash
Bay 2	...	3.94 ,, ,,
Bay 3	...	4.59 ,, ,,

Now, if potash supplies were unrestricted a "standard" dressing would be of the order of 4 ounces per square yard which we suggest is in close agreement with the quantities suggested by the analysis.

In Bay 4 analysis suggests that 7.2 ounces per square yard should be used.

Phosphoric Acid

The results for the extraction of phosphoric acid are given in Tables 4 and 5. In considering these the following facts can be borne in mind.

(1) That irrespective of the level of the phosphoric acid in the soil, the addition of some water soluble phosphate is usually necessary in propagating soil and often at planting out.

(2) The phosphoric acid content of a good tomato crop is relatively low, being only about a tenth of the potash content.

TABLE 4

Per cent. P_2O_5

Date sample was collected	*Manurial Treatment applied ½ to 1 day after sample was collected*	*Extracted by 1% citric acid*	*Extracted by N/2 acetic acid*	*Extracted by distilled water (Results in parts per million)*	*Extracted by Morgan's solution*	*Extracted by Truog's solution*
February 1943 ..		0.22	0.215	18.22	0.047	0.128
April 25th ..		0.262	0.244	18.8	0.056	0.133
May 20th ..	1 oz. per sq. yard of Nitrate of soda	0.225	0.204	18.8	0.054	0.127
June 1st ..	1 oz. per sq. yard of superphosphate	0.261	0.221	24.1	0.066	0.143
June 12th ..		0.256	0.262	52.57	0.095	0.182
July 7th ..	2 ozs. per sq. yard of Mixture: 10.4% N, 4.8% P_2O_5, 4.5% K_2O	0.256	0.246	31.3	0.071	0.159
July 27th ..	2 ozs. per sq. yard of a mixture 7.2% N, 7.9% P_2O_5, 5.9 K_2O	0.251	0.237	34.12	0.078	0.166
Sept. 15th ..		0.243	0.234	19.35	0.066	0.149
Nov. 9th ..	(Winter flooding Nov. 2nd) ..	0.237	0.232	22.66	0.061	0.138

(3) For normal soils where the phosphoric acid content is 0.1 per cent. or more, little or no phosphate need be added beyond that referred to in (1) above.

(4) The losses of phosphoric acid in drainage from a tomato soil rich in calcium carbonate are negligible.

Reference to Tables 4 and 5 will show that at no time was there likely to be any deficiency of phosphoric acid except, possibly in so far as it might influence the uptake of other ions.

Several other points of interest occur in the 1943 results. The addition of 1 ounce per square yard of superphosphate increased the phosphoric acid extracted in all cases. When, however, the superphosphate is added as constituent of mixtures as on July 7th and 27th, the effect is not so consistent ; in 10 pairs of results 3 show increases, 6 show decreases and 1 is unchanged.

Under these conditions the values for the phosphoric acid extracted by citric acid and acetic acid are sufficiently near to assume they are the same.

The results for 1944 are given in Table 5.

Here it is noteworthy that in Bay 4 which was unmanured throughout the season, the values for phosphoric acid extracted by citric acid are consistently higher than those for acetic acid. Even so, however, the values are all well above what may be regarded as critical.

The increases in water soluble phosphate following the dressings (Bays 1-3) are probably due to the fact that although the phosphate status is high when judged on the basis of acid extraction, the amount soluble in water is low and increases when superphosphate is added are bound to be reflected. After 24th June, 1944 when dressings were discontinued these values declined and this is presumably due to reversion of phosphate into forms which are insoluble in water.

On the basis of the foregoing paragraph it is clear that where the phosphate soluble in acids is high, the *relatively* small amount of phosphate added has a correspondingly smaller effect but in general the trends are similar.

As before the amounts of phosphate extracted by acetic acid and citric acid respectively are of the same order.

Finally, Tables 6 and 7 show the total nitrogen determinations for the plots in 1943 and 1944 respectively. These are what may be termed normal values for this type of soil and compared with nitrogen already present, the amounts added in the dressings are comparatively small and would not have any considerable influence on the values.

Table 6

Date	*Treatment* ½ *to* 1 *day after sampling*	*Nitrogen per cent*
1943		
Feb.		.277
April 25th		.250
May 20th	1 oz./sq. yd. Sodium Nitrate	.243
June 1st	1 oz./sq. yd. superphosphate	.257
June 12th		.251
July 7th	2 ozs./sq. yd. mixture :— 10.4% N, 4.8% P_2O_5 4.5% K_2O	.251
July 27th	2 ozs./sq. yd. mixture :— 7.2% N, 7.9% P_2O_5 ; 5.9% K_2O	.231
Sept. 15th		.239
Sept. 2nd	Winter flooding	
Sept. 9th		.238

The obvious development of this work is the determination of the ratio :—

$$\frac{\text{Potash soluble in N/2 acetic acid.}}{\text{Potash soluble in 1 per cent. citric acid}}$$

for tomato soils of different types. This would confirm or invalidate the figure of 2.45 which the present work suggests, and also the conclusion tentatively made that N/2 acetic acid and 1 per cent. citric acid do extract different categories of potash.

References

(1) Williams, R. J. Agric. Sci. 1928, 18, 439.

(2) Morgan, M. F., Bull. 392, 1937 and Circular 127, 1939, Coun. Agric. Exp. Station.

(3) Truog, E., J. American Soc. Agronomy, 1930, 22, 874.

(4) Owen, O. Exp. Res. Sta., Cheshunt, 1933, 79.

(5) ———— Res. Sta., Cheshunt, 1935, 81.

Table 7.

Percentage Total Nitrogen

Sample	*Treatment*	*Bay 1*	*Bay 2*	*Bay 3*	*Bay 4*
11/3/44					
15/4/44	Bay 1 1 oz. dried blood		0.238 %		
	1 oz. superphosphate ...		0.235 %		
	Bay 2 1 oz. dried blood				
	Bay 3 1 oz. sulphate of ammonia				
	1 oz. dried blood				
	Bay 4 Untreated				
27/5/44	Bay 1 2 ozs. dried blood	0.236%	0.246%	0.244%	0.244%
	2 ozs. sulphate of potash ...				
	2 ozs. superphosphate ...				
	Bay 2 2 ozs. dried blood				
	2 ozs. sulphate of potash ...				
	Bay 3 2 ozs. dried blood				
	2 ozs. sulphate of potash ...				
	1 oz. sulphate of ammonia...				
	Bay 4 Untreated				
24/6/44	Bay 1 1 oz. sulphate of potash ...	0.249	0.252	0.266	0.254
	1 oz. dried blood				
	Bay 2 1 oz. sulphate of potash ...				
	1 oz. dried blood				
	Bay 3 1 oz. sulphate of potash ...				
	1 oz. dried blood				
	Bay 4 Untreated				
27/7/44		0.270	0.250	0.291	0.246
16/8/44		0.252	0.253	0.261	0.255
18/9/44	Before steaming	0.250	0.252	0.248	0.244
21/9/44	After steaming	0.232	0.246	0.243	0.258
23/10/44	Winter flooding on 10/10/44 ...	0.244	0.260	0.248	0.249
18/11/44		0.239	0.255	0.259	0.254
20/12/44		0.246	0.246	0.270	0.278

APPENDIX A.

PUBLICATIONS

1919.

PAINE, S. G. and W. F. BEWLEY. Studies in Bacteriosis IV. " Stripe." Disease of Tomato. Ann. appl. Biol., VI, 183-202.

1920.

BEWLEY, W. F. " Damping off " and " Foot-rot " of Tomato Seedlings. Ann. appl. Biol., VII, 156-172. (Abridged account J. Minist. Agric. XXVII, 670-673.)

LLOYD, LL. The Habits of the Glasshouse Tomato Moth, *Hadena* (Polia) *oleracea* and its Control. Ann. appl. Biol., VII, 10-19.

PAINE, S. G. and W. F. BEWLEY. " Stripe " Disease of the Tomato. J. Minist Agric., XXVI, 998-1,000.

1921.

BEWLEY, W. F. Control of " Damping off " and " Foot-rot " of Tomatoes J. Minist. Agric., XXVIII, 653-654.

——————— and W. BUDDIN. On the fungus flora of Glasshouse Water Supplies in relation to Plant Disease. Ann. appl. Biol., VIII, 10-19.

1922.

BEWLEY, W. F. " Sleepy Disease " of the Tomato. Ann. appl. Biol., IX, 116-134.

——————— Anthracnose of the Cucumber under Glass. J. Minist. Agric., XXIX, 469-472, and 558-562.

——————— " Tomato Diseases." J. R. hort. Soc., XLVII, 169-174.

LLOYD, LL. The Control of the Greenhouse White Fly, with notes on its biology. Ann. appl. Biol., IX, 1-34.

1923.

BEWLEY, W. F. Diseases of Glasshouse Plants. 208 pp. (Benn, Lond.).

——————— " Sleepy Disease " of the Tomato. J. Minist. Agric., XXX, 450-457.

OWEN, O. Carbon Dioxide in relation to Glasshouse Crops. Part 1. Ann. appl. Biol., X ,312-317.

——————— and P. H. WILLIAMS. Carbon Dioxide in relation to Glasshouse Crops. Part II. Ann. appl. Biol., X, 318-325.

PAINE, S. G. and W. F. BEWLEY. Further Investigations of the " Stripe " Disease of Tomato. Ann. appl. Biol., X, 89-95.

SPEYER, E. R. Mycetophilid Flies as Pests of the Cucumber Plant in Glasshouses. Bull. Ent. Res., XIII, 255-259.

1924.

BEWLEY, W. F. and J. SHEARN. A Root Disease of the Tomato caused by *Colletotrichum tabificum* (Hallier pro parte) Pethybridge. Ann. appl. Biol., XI, 244-251.

SPEYER, E. R. and O. OWEN. The action of some Organic Compounds upon the Cucumber House Wood-louse. Ann. appl. Biol., XI, 236-243.

1926.
BEWLEY, W. F. Practical Soil Sterilisation by Heat for Glasshouse Crops. J. Minist. of Agric., XXXIII, 297-311.

———————— Note on the Preservation of Plate Cultures of Fungi. Ann. appl. Biol., XIII, 577-579.

———————— Diseases of Glasshouse Plants. Essex Farmers' J. V. parts 1 and 2.

———————— and H. L. WHITE. Some Nutritional Disorders of the Tomato. Ann. appl. Biol., XIII, 323-338.

OWEN, O., T. SMALL and P. H. WILLIAMS. Carbon Dioxide in relation to Glasshouse Crops. Part III. Ann. appl. Biol., XIII, 560-576.

SPEYER, E. R. and OWEN, O. The Fumigation of Tomato Houses with Hydrocyanic Acid Gas. Ann. appl. Biol., XIII, 144-147.

1927.
SPEYER, E. R. An important Parasite of the Greenhouse White Fly, (*Trialeurodes vaporariorum*, Westwood). Bull. Ent. Res., XVII, 301-8.

SMALL, T. Rhizoctonia " Foot-rot " of the Tomato. Ann. appl. Biol., XIV, 290-295.

1928.
SMALL, T. A Disease of the Strawberry Plant. J. Pomol., VII, 212-215.

SPEYER, E. R. The Red Spider Mite (*Tetrynychus Telarius*, L.). J. Pomol, VII, 161-171.

1929.
BEWLEY, W. F. The Effect of Environmental Conditions on Plant Diseases under Glass. Ann. appl. Biol., XVI, 190-192.

———————— The Influence of Bright Sunshine upon the Tomato under Glass. Ann., appl. Biol., XVI, 281-7.

———————— The Practical Sterilisation by Heat of small quantities of Soil. J. Minist. Agric. XXXVI, 623-634.

OWEN, O. The occurrence of Chlorates in a Tomato Soil. J. Pomol., VII, 270-275.

———————— The Effect of Copper Sulphate on Tomato Plants. Ann. appl. Biol., XVI, 430-437.

———————— The Analysis of Tomato Plants, Part I. J. agric. Sci., XIX, 413-432.

SMALL, T. Temperature and Humidity in relation to Tomato Leaf Mould. Ann. appl. Biol., XVI, 192-193.

SPEYER, E. R. The Greenhouse White Fly. J. R. hort. Soc. LIV, 181-92.

WHITE, H. L. The Wilt Disease of the Carnation. J. Pomol, VII, 303–323.

1930.
BEWLEY, W. F. Some Experiments on the Heating of Glasshouse Soil by Electricity. Rep. and Proc., IXth Internat. Hort. Congress, London.

———————— and B. D. BOLAS. Aucuba or Yellow Mosaic of the Tomato Plant : Reaction of Infected Juice. Nature, CXXV, 130.

———————— and W. CORBETT. The " Maturation Period " of the Tomato Plant. Ann. appl. Biol., XVII, 267-279.

———————— and ———————— The Control of Cucumber and Tomato Mosaic Diseases in Glasshouses by the use of Clean Seed. Ann. appl. Biol., XVII, 260-266.

1930.

BOLAS, B. D., and W. F. BEWLEY. Aucuba or Yellow Mosaic of Tomato ; A note on metabolism. Nature CXXVI (3178), 471.

JOZEFOWICZ, MARY. The Effect of certain Treatments on the Germination of Tomato Seeds. Ann. appl. Biol., XVII, 504-513.

———————— Some Observations on Tomato Plants from Seed submitted to High Temperatures. Ann. appl. Biol., XVII, 514-521.

SMALL, T. The Relation of Atmospheric Temperature and Humidity to Tomato Leaf Mould (*Cladosporium fulvum*). Ann. appl. Biol., XVII, 71-80.

———— and H. L. WHITE. Carbon Dioxide in relation to Glasshouse Crops. Part IV. Ann. appl. Biol., XVII, 81-89.

WHITE, H. L. Carbon Dioxide in relation to Glasshouse Plants, Part V. Ann. appl. Biol., XVII, 755-766.

1931.

BEWLEY, W. F. The Nature of the Virus Principle in Mosaic Disease. Nature, CXXVII, 442.

———————— Practical Soil Sterilisation with special reference to Glasshouse Crops. Bull. Minist. Agric., No. 22.

OWEN, O. The Analysis of Tomato Plants. Part II. The Effect of Manurial Treatment on the composition of Tomato Foliage. J. agric. Sci. XXI, 442-451.

SMALL, T. Experiments on the Control of Tomato Leaf Mould (*Cladosporium fulvum*) by Fungicides and Fumigants. Ann. appl. Biol., XVIII 305-312.

1932.

BEWLEY, W. F. Some recent developments in relation to Glasshouse Crops. H.E.A. Year Book, I, 23-26.

———————— and O. B. ORCHARD. The Control of Tomato Leaf Mould. Ann. appl. Biol., XIX, 185-189.

READ, W. H. The Toxicity of the Vapours of Volatile Organic Compounds to the " Red Spider " Mite (*Tetranychus telarius* L.) Ann. appl. Biol. XIX, 432-438.

1933.

AINSWORTH, G. C. An Investigation of Tomato Virus Diseases of the Mosaic " Stripe " Streak Group. Ann. appl. Biol., XX, 421-428.

BOLAS, B. D., and R. MELVILLE. The Influence of Environment on the Growth and Metabolism of the Tomato Plant. I. Methods, technique and preliminary results. Ann. Bot., Lond., XLVII, 673-688.

READ, W. H. and O. B. ORCHARD. Plant Injury following the burning of sulphur in empty glasshouses. J. Minist. Agric., XXXIX, 1085-1086.

SECRETT, F. A. and BEWLEY, W. F. Cultivation of Lettuce for Market, Pamp. issued by R. hort. Soc.

1934.

AINSWORTH, G. C., G. H. BERKELEY, and J. CALDWELL. A comparison of English and Canadian Tomato Virus Diseases. Ann. appl. Biol., XXI, 566-580.

———————— A comparison of certain English and Canadian Potato Viruses found infecting Tomatoes. Ann. appl. Biol., XXI, 581-587.

1934.
BEWLEY, W. F. Health and Disease in Plants. J. R. hort. Soc., LIX, 386-396.

———— Some Physiological Disorders of Glasshouse Crops. Ann. appl. Biol., XXI, 319-22.

———— Raising the Soil Temperatures in Glasshouses. J. Minist. Agric., XL, 1047-56.

———— Tomatoes : Cultivation, Diseases and Pests. Bull. Minist. Agric., No. 77, 71 pp.

———— and HARNETT, J. The Cultivation of Mushrooms. 63 pp. Anglo-Scottish Press, London).

SPEYER, E. R. Some common species of the genus *Thrips* (Thysanoptera) Ann. appl. Biol., XXI, 120-52.

1935.
AINSWORTH, G. C. Spotted Wilt of Richardias (Arums). Gdnrs'. Chron., XCVII (2507), 31.

———— Mosaic Diseases of Cucumber. Ann. appl. Biol., XXII, 55-67.

———— Virus Diseases of the Cucumber. J. Minist. Agric. XLII, 338-44.

———— Another new Virus Disease of the Tomato. Grdnrs'. Chron., XCVIII, 320-1.

———— Fig. Mosaic. J. R. hort. Soc., LX, 532-3.

BEWLEY, W. F. Cheshunt Early Giant Lettuce ; a new forcing type. J. Minist. Agric., XLII, 45-7.

BOLAS, B. D. and R. MELVILLE. The effect on the Tomato Plant of Carbon Dioxide produced by combustion. Ann. appl. Biol., XXII, 1-15.

———— and SELMAN, I. W. An inexpensive recording Porometer. Ann. Bot., Lond., XLIX, 803-8.

1936.
AINSWORTH, G. C. Detection of Spotted Wilt in Chrysanthemums. Nature, Lond., CXXXVII, 868.

———— " Bushy Stunt " : a Virus Disease of the Tomato. J. Minist. Agric. XLIII, 266-9.

———— and SELMAN, I. W. Some Effects of Tobacco Mosaic Virus on the Growth of Seedling Tomato Plants. Ann. Appl. Biol., XXIII, 89-98.

BEWLEY, W. F. Tomato Production for High Quality Fruit. Misc. Pub. No. 1, Exp. Sta. Cheshunt, pages 1-20.

SPEYER, E. R. Injury to Carnation Flowers caused by Thrips. Carnation Year Book, 14-18 Figs. 1-6.

WHITE, H. L. On Verticillium Wilt of the Perpetual-Flowering Carnation. J. Pomol., XIV, 216-26.

———— Anther Smut of the Perpetual Flowering Carnation. Gdnrs'. Chron., C. 254.

WILLIAMS, P. H. A new Eelworm Disease of the Tomato. Gdnr's. Chron. XCIX, 316.

———— A Disease of Mushrooms new to Great Britain. Gdnrs'. Chron., C. (2591), 147.

———— Some important Disease of Glasshouse Plants. Ann. appl. Biol. XXIII, No. 1. 189-192.

1937.
AINSWORTH, G. C. The Plant Diseases of Great Britain : A bibliography pp. XII. W L. 273 (Chapman & Hall, Ltd., London).

———————— " Enation Mosaic " of Tomato caused by a virus of the *tobacco virus* 1 type. Ann. appl. Biol., XXIV, 545-556.

———————— OYLER, E. and READ, W. H. The Spotting of Tomato Fruit by *Botrytis*. Gdnrs'. Chron., CII. (2656), 380-381.

BEWLEY, W. F., HARNET, J., and WILLIAMS, P. H. The Control of White Plaster Mould (*Oospora fimicola*) on Mushroom Beds. Gdnrs'. Chron., CII (2642), 130.

OWEN, O. Note on the use of Chlorate Weed-killers. J. Minist. Agric., XLIV, 866-869.

OYLER, E., and BEWLEY, W. F. A Disease of Cultivated Heaths caused by *Phytophthora Cinnamoni* Rands. Ann. appl. Biol., XXLV, 1-16.

MELVILLE, R. The influence of environment on the growth and Metabolism of the tomato plant. II The relationship between water content and assimilation. Ann. Bot., Lond. N.S.I., 153-174.

1938.
AINSWORTH, G. C. A Note on certain viruses of the *Cucumber virus* 1 type isolated from monocotyledonous plants. Ann. appl. Biol., XXV (4), 867-869.

———————— ENID OYLER and W. H. READ. Observation on the Spotting of Tomato Fruits by *Botryis cinerea* Pers. Ann. appl. Biol., XXV (2), 308-31.

BEWLEY, W. F. Recent Work on Rose Disease, Sci. Hort. VI, 97-101.

———————— and HARNET, J. The Cultivation of Mushrooms. Revised and enlarged edition, p. 95. (Anglo-Scottish Press, Ltd.).

OWEN, O. V.Chlorate Weedkillers. Ann. appl. Biol., XXV (3), 659-660.

SPEYER, E. R. The Carnation Tortrix. Carnation Year Book, 21-30, figs. 1-9.

———————— Pests of the Carnation and their Control. Sci. Hort., Vol. VI. 72–84, figs. 20–21.

WHITE, H. L. Stem-Rot and Wilt of the Perpetual Flowering Carnation. Sci. Hort. VI, 86-92.

———————— Observations of the Effect of Nitrogen and Potassium on the Fruiting of the Tomato. Ann. appl. Biol. XXV, 20-49.

———————— Further Observations of the Incidence of Blotchy Ripening of the Tomato. XXV, 544-557.

———————— The Anther Smut Disease of the Perpetual Flowering Carnation. British Carnation Soc. Year Book, 40-43.

———————— The Sterilization of Lettuce Seed. Ann. appl. Biol. XXV. 767-780.

WILLIAMS, P. H. Investigation on the Rust of Roses *Phragmidium mucronatum* Fr. Ann. appl. Biol. XXV (4) 730-741.

BOLAS, B. D., MELVILLE, R. and SELMAN, I. W. The measurement of assimilation and translocation in tomato seedlings under the conditions of glasshouse culture. Ann. Bot. Lond. N.S. II 717-728.

1939.
AINSWORTH, G. C. The Nomenclature of Plant Viruses. Chron. Bot. V, 193-194.

1939

———————— and OGILVIE, L. Lettuce Mosaic. Ann. appl. Biol., XXVI, (2), 279-297.

SPEYER, E. R. and READ, W. Red Spider-Mite (*Tetranychus telarius* L) Carnation Year Book 6-16, Figs. 1-12.

WILLIAMS, P. H. A Mushroom disease caused by *Mycogone rosea*, Gdnrs'. Chron. CV, 2, 729, p. 236.

1940.

AINSWORTH, G. C. The identification of certain viruses found infecting leguminous plants in Great Britain. Ann. Appl. Biol. XXVII, 218-226.

GOODALL D. W., and BOLAS, B. D. Vernalisation of tomatoes. Gnrs' Chron. CVIII, 261-262. Reprinted in Fruitgrower, XCI 27 (1941).

1941.

PARR, W. J. and SPEYER, E. R. Some observations on the Life History of the Angle Shades Moth (*Brotolomia Meticulosa* L). Ann. Appl. Biol. XXVIII No. 1, pp. 29-33.

SELMAN, I. W. Control of plant virus diseases by cultural methods. Nature (London) 147, 181-182.

———————— Spotted Wilt Diseases of Tomatoes, Gard. Chron. CIX 241-242.

———————— The effects of certain mosaic-inducing viruses on the tomato crop under glass. Journ. Pom & Hort. Sci. XIX, 107-136.

SPEYER, E. R. and PARR, W. J. The External Structure of some Thysanopterous Larvae. Trans. R. Ent. Soc. Lond., Vol. 91, Part 2, pp. 559-635.

1942.

SELMAN, I. W. The relation between mosaic infection and yield reduction in glasshouse tomatoes. Journ. Pom. and Hort. Sci. XX 49-58.

ENID OYLER and W. H. READ. A Stem Rot of tomato caused by *Didymella lycopersici*. Gard. Chron. CXII. No. 2910, p. 121.

GOODALL, D. W. and BOLAS, B. D. Vernalization of tomato seed. Ann. Appl. Biol. XXIX, 1-10.

1943.

WILLIAMS, P. H. and ENID SHEARD. Stem Rot of Tomato caused by *Phytophthora parasitica*. Gard. Chron. CXIV. No. 2959, p. 96.

SELMAN, I. W. The influence of lime and potash on Mosaic infection in the tomato (var. Potentate) under glass. J. Pom. XX, 89-106.

———————— " The appearance and spread of Mosaic infection in the tomato crop and the relation to seed transmission of the Virus." Ann. Appl. Biol. 30. 331-338.

1944.

SELMAN, I. W. The susceptibility of lettuce to mosaic virus in relation to Nitrogen Phosphate and water supply. J. Pom. XXI, 28-33.

———————— Virus infection and water loss in tomato foliage. J. Pom. XXI, 146-154.

GOODALL, D. W. Proportion of leaves to flower trusses in the tomato plant. Gard. Chron. CXV, 39.

APPENDIX B

Manurial Treatment in Tomato experiments

(Except plots in Appendix C)

(1) Lime

All houses with the exception of Plots 5 and 6 in house 4 and house 5 received hydrated lime at the rate of 10 cwts. per acre.

(2) Base Dressing

Houses 7-10 and the cucumber houses were steamed and received sulphate or muriate of potash at the rate of half ton per acre only.

The remaining houses 1-5 received, hoof and horn, bone meal and sulphate of potash each at the rate of half ton per acre.

(3) Top dressings

Sulphate of potash.—All houses received a first top dressing of sulphate of potash at the rate of 5 cwts. per acre excepting those receiving muriate of potash in Houses 7, 8 and 9.

Fertilisers Mixture.—All houses except plots 1, 2, 5, 9 and 10 received 5 cwts. per acre of a war time mixture every fourteen days at discretion.

Appendix C.

Manures applied in Plots 1-3, and 10-12 in Tomato House 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				* Top-dressing in Lbs. per sq. yd.		
		Lime.	Stable Manure.	Super-phosphate	Sulphate of Potash.	Super-phosphate.	Sulph. of Ammonia.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2
10	Complete Artificials with Dung	1.0	7	0.4	0.1	0.5	0.2	0.2
11	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2
12	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	—

* The Top-dressing was applied in eight equal instalments.

Appendix D.

Dates of Cultural Operations, 1943—1944.

Crop.	Sown.	Potted into 60's.	Planted out in borders.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Tomatoes ...	Dec. 14 1943	Jan. 9 1944	Mar. 8–11 1944	April 28 1944	May 25 1944	July 21 1944

Month.	Air Temperatures						Grass Temp.			Rainfall				Mean Soil Temperatures		Hygrometer				Bright Sunshine		Barometer
	Mean		Absolute Max.		Absolute Min.		Av. Min.	Absolute Min.		Total Precipitation	No. of Days P'ptn.	Greatest Fall		1 ft.	2 ft.	Dry Bulb	Depres. of Wet Bulb	Relative Humidity %	Dew Point	Total No of Hrs.	Daily Average.	
	Max.	Min.	Tem.	Date	Tem.	Date		Tem.	Date			Amt.	Date									
	°F.	°F.	°F.		°F.		°F.	°F.		Ins.		Ins.		°F.	°F.	°F.	°F		°F.			Ins.
January	48.8	36.7	55.0	27th 30th	24.0	10th	32.4	19.0	4th 10th	1.36	12	0.32	22nd	41.8	42.4	42.1	1.4	89.3	39 1	38.0	1.23	30.15
February	43.6	33.2	56.0	2nd	24.0	23rd	28.9	18.0	5th 23rd	1.08	11	0.44	16th	40.2	41.6	38.0	1.6	85.9	34.0	53.6	1.85	30.07
March	50.1	33.2	71.0	26th	25.0	5th	27.0	19.0	5th	0.18	5	0.06	13th 29th	39.2	40.1	41 5	1.7	85.9	37.5	88.0	2.84	30.08
April	60.6	42.0	73.0	30th	33.0	18th	37.1	29.0	9th 11th 18th	1.42	10	0.53	3rd	48.3	47.4	49.7	2.2	85.5	45.2	124.6	4.15	30.05
May	66.2	42.1	89.0	29th 30th	28.0	7th	38.0	23.0	6th 7th	0.51	6	0.14	16th	52.7	52.2	54.7	4.7	72 5	45.6	225.0	7.26	30.09
June	67.3	48.9	78.0	24th	38.0	23rd	45.7	32.0	23rd	2.12	13	0.58	1st	57.8	56.8	59.0	4.2	76.7	51.1	187.4	6.25	29.91
July	72.7	55.3	80.0	16th 17th 26th	46.0	11th	52.1	43 0	11th	2.04	14	0.81	3rd	62.3	60.8	65.0	4.2	77.2	57.3	145.8	4 70	29.90
August	75.5	55.2	84.0	12th	48.0	13th	52.3	44.0	6th 13th	3.01	12	1.36	24th	62.7	62.1	65.1	3.9	79.6	58.1	202.2	6.52	29.96
September	63.5	47.0	72 0	14th	36.0	9th	42.1	30.0	9th	2.44	14	0.50	23rd	56.5	57.0	56.4	2.7	83.1	51.7	125.9	4.20	29 97
October	55.4	42.7	60.0	6th 14th 15th	31.0	28th	37.6	26.0	27th	3.39	17	0 58	16th	51.3	52.2	50.4	2.2	85.8	46.0	84.5	2.73	29.76
November	50.3	37.2	60.0	4th 5th 6th	22.0	11th	31.6	20.0	11th	3.72	18	1,32	17th	45.4	46.7	43.8	1.1	92.1	41.5	50.6	1.69	29 71
December	42.7	31.6	54,0	17th	20.0	27th	26.4	13.0	27th	1.33	13	0.52	16th	41.1	42.6	38.2	0.9	92.1	36.0	51.6	1.66	29.86

Total rain for year, 22.60 ins. No. of days precipitation, 145. Total bright sunshine for year, 1377.2 hours.